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ABSTRACT

The ecological theme of "We all need each other--the web of life" serves as the focus of Alaska's fourth annual wildlife week and as the emphasis for the activities in this guide for junior/senior high school teachers. The packet of materials contain: (1) an introduction (explaining the theme); (2) table of contents (indicating each lesson's objective and the location of its background sheets, student worksheets and activities, and curriculum integration ideas); (3) list of worksheets (providing title, summaries, and page numbers for the 11 activities); (4) worksheet solutions (listing answers and/or explanations for each of the exercises); (5) glossary (defining major ecological terms); (6) science word mysteries (offering an exercise dealing with scientific word roots); (7) ecology crossword puzzle; (8) lessons (containing objectives, background information, vocabulary list, activities, and curriculum integration suggestions); (9) classification guide (explaining the five kingdoms of living things); (10) Alaskan food chain and food web examples (citing specific relationships common to four ecosystems); and (11) references. (ML)

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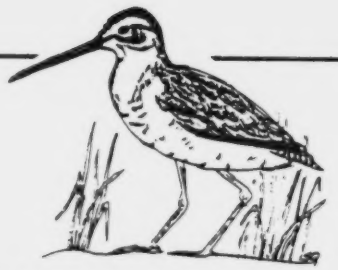

Alaska Wildlife Week 1986
Introduction

This is the fourth annual Alaska Wildlife Week . This annual celebration of the importance and value of wildlife to Alaskans is a time for learning about wildlife and conservation. In recognition of this event, the Alaska Department of Fish and Game, Nongame Wildlife Program annually prepares a new set of educational materials for teachers throughout the state. We began developing the packets in response to teacher requests for Alaska-specific information on wildlife and conservation. Originally patterned after the National Wildlife Week sponsored by the National Wildlife Federation, Alaska Wildlife Week has continually evolved in response to teacher's needs, requests, and evaluations. We hope that these 1986 materials are the best yet.

Separate Primary, Upper Elementary, and Junior/Senior High School Teacher's Guides were prepared this year to make the materials easier for you to use during Alaska Wildlife Week, and throughout future years. Be sure you have the appropriate Teacher's Guide. Also included are more posters, many easy to duplicate worksheets, and a wide variety of activities for use with your regular curriculums. This year's packet is organized so that each lesson builds on the previous ones. The activities are intentionally varied to meet the differing needs of teachers and students throughout Alaska. Feel free to pick and choose among the materials based on your particular situation and your students. Adapt and modify activities or worksheets if you desire. The important thing is to get the concepts across.

As always, we would like to encourage you to integrate Alaska Wildlife Week with other conservation education materials-- Project WILD, Alaska Sea/River Week, CLASS Project, and National Wildlife Week all offer additional ideas, approaches, and perspectives on wildlife and the natural world.

The Alaska Wildlife Week 1986 theme is "We all need each other --the web of life." The unit is on ecology--the study of the inter-relationships among living things and their non-living surroundings. Ecology is a synthesis of many sciences and has application in all human endeavors. In learning to understand ecology, students will be challenged to think, question, observe, and reflect about wildlife--a topic in which most students are inately interested. The study of ecology can lead students to an interest and appreciation for all the natural sciences--biology, chemistry, and physics. Further, ecology is a science that is critical not only for for wildlife conservation, but also for the future of humans.

Never-the-less, ecology has been called "an elaboration of the obvious". Don't allow yourself to be frightened off by an occasional scientific-sounding word. Ecology is probably the easiest science to understand, and certainly one of the most fascinating. At some level, most people know the basic concepts of ecology without really being aware of it. Oddly, however, gaining an awareness of these intuitively obvious concepts is like putting on a pair of glasses that allow you to see the world as though for the first time.

Please use this packet and help your students put on a pair of "ecology glasses" that will let them see the world around them with new eyes.

P.S. Keep your notes, hang on to your packets, and incorporate your favorite lessons and activities into your curriculum. The Alaska Wildlife Week theme changes every year, but the information and materials in each year's packets continue to be relevant. In addition, the themes all center around wildlife and are interlocking. If you have saved materials from past years, you'll find many of them relevant to this year's Alaska Wildlife Week theme.

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LESSON / OBJECTIVE	TEACHER BACKGROUND	INTRODUCTORY ACTIVITY	STUDENT WORKSHEET	IDEAS FOR CURRICULUM INTEGRATION
1. Students will be able to differentiate living and non-living things and be able to identify the kinds of each that occur in ecosystems.		11-12	13	14-28
2. Students will be able to explain the movement of energy from the sun through the food chains and webs of an ecosystem in their area.		33-34	35-36	37
3. Students will be able to explain the cycles of water, carbon, nitrogen, and other minerals through ecosystems.		45-46	47-50	51-52
4. Students will be able to identify the 5 ways (predation, competition, mutualism, commensalism, and parasitism) that populations of living things in ecosystems interact and affect each other.		57	58	71-76
5. Students will be able to identify the ecosystem components that are important for conservation of specific wildlife and/or humans.		81	82	83-86

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You will see, too, that modern natural history deals only incidentally with the identity of plants and animals, and only incidentally with their habits and behaviors. It deals principally with their relations to each other, their relation to the soil and water in which they grew, and their relations to the human beings who sing about "my country" but see little or nothing of its inner workings. This science of relationships is called ecology, but what we call it matters nothing. The question is, does the educated citizen know he is only a cog in an ecological mechanism? .....If education does not teach us these things, then what is education for?

Aldo Leopold

NO#	WORKSHEET TITLE AND USE	PAGE
1	SCIENCE WORD MYSTERIES Students use Latin and Greek roots to determine the meanings of ecology terms.	7
2	ECOLOGY CROSSWORD Reinforces definitions and spellings of ecology terms.	8
3	ECOSYSTEMS WORKSHEET Reinforces differentiation of living and non-living things, classification of living things into 5 kingdoms, and concept that ecosystems include both the non-living environment and living things.	13
4	LIVING THINGS BINGO Use for a game to reinforce the classification of living things into 5 Kingdoms: Monerans, Protists, Fungi, Plants, and Animals. For use with Lesson 1.	16
5	ECOSYSTEM INVESTIGATION WORKSHEETS Set of 7 worksheets intended to lead students in field discovery of the non-living environment, microscopic organisms, fungi, plants, small mammals, birds and large mammals, and aquatic life in the ecosystem around them.	19
6	FOOD CHAIN WORKSHEET Reviews and reinforces food chain and food web concept and identification of living things as producers, herbivores, carnivores, detritivores and omnivores.	36
7	ECOSYSTEM CYCLES Reviews and evaluates student understanding of ecosystem mineral cycles, including water, carbon, nitrogen, and phosphorus.	47
8	ECOPATHS GAME A board game that teaches and reinforces the cycles of carbon, water, nitrogen and other minerals through ecosystems.	48
9	ECOSYSTEM INTERACTIONS Reviews and evaluates student understanding of the 5 kinds of interactions that occur between living things: predation, competion, commensalism, mutualism, parasitism.	58
10	MY FAVORITE LIVING THING Student uses concepts of previous lessons to identify ecosystem components important to their favorite kind of wildlife	82
11	ECOLOGY PUZZLERS Student uses knowledge of ecology to and facts to predict consequences of various ecosystem changes. Observations and predictions of ecologists are presented seperately.	87

WORKSHEET SOLUTIONS

1. SCIENCE WORD MYSTERIES-- 1-aa, 2-t, 3-b, 4-a, 5-c, 6-d,7-q, 8-p,9-e, 10-f, 11-j, 12-o, 13-h, 14-w, 15-x,16-z, 17-bb, 18-y, 19-r, 20-s, 21-u, 22-v, 23-i, 24-g, 25-k, 26-l, 27-m, 28-n. These letters fill in the blanks at the bottom to spell "Super Ecology Word Detective."

2. ECOLOGY CROSSWORD--see page 95 for the solution.

3. ECOSYSTEMS WORKSHEET--1- a; 2-e; 3-c; 4-a; (only definitely living if they reproduced); 5-s,6-o, 7-l, 8-s, 9-n, 10-o, 11-l, 12-g, s-insect; 14-i, 15-t, 16-i (must have both living and non-living things). The words at the bottom are "an ecologist."

4. LIVING THINGS CLASSIFICATION--self-explanatory.

5. ECOSYSTEM INVESTIGATION WORKSHEETS--self-explanatory.

6. FOOD CHAIN WORKSHEET--mushroom-D; copepod-H; willow-P; alpine avens-P, grebe-C, merlin-C, green algae-P, raven-D, mosquito larvae-C, wolf-C, sandlance-C, stickleback-C, shrike-C, loon-C, diatom-P, redpoll-H, seal-C, crab-D, Dall sheep-H, dragonfly-C, killer whale-C, bacteria-D, pika-H, red fox-O, marmot-H, golden eagle-C, longspur-O, amoeba-C.

7. ECOSYSTEM CYCLES-- top left--fungi and animals breathe in oxygen and give off carbon dioxide; plants and algae actually breate in and give off both gases, but they give off more oxygen than carbon dioxide. Top right--detritivores--the mineral cycle would break down without them and plants would run out of needed minerals; lower left--nitrogen-fixing bacteria; lower right--plants, transpiration, the amount of moisture in the air would decrease, meaning less precipitation and more airborne dust.

8. ECOPATHS GAME--self -explanatory, rules on p. 50.

9. ECOSYSTEM INTERACTIONS--v--competition, b-mutualism, g-predation, y-parasitism, h-commensalism; 52-y, 53-g, 54-b, 55-h, 56-h, 57-b, 58-g, 59-b, 60-y, 61-g, 62-v, 63-b, 64-b, 65-v The message at the bottom says "Symbiosis mean living together."

10. MY FAVORITE LIVING THING--see Lesson 5 introductory activity for instructions on use; last word on worksheet is "ecosystem."

11. ECOLOGY PUZZLERS--"solutions" provided on consecutive pages.

AN ECOLOGY DICTIONARY

JR / SR HIGH

animal	living things in the Kingdom Animalia, one of the 5 major groups of living things that includes invertebrates (insects, crustaceans, echinoderms, worms, etc.) and vertebrates (birds, mammals, fish, amphibians); characterized by their highly organized, multicellular structure. All are consumers.
autotroph	an organism that can make its own food
carbon	an element that forms that basic building block of all living things
carnivore	an organism that eats consumers; meat eater
commensalism	association between two kinds of living things, where one benefits and the other is unaffected
competition	the interaction between two kinds of living things that use the same limited resource
consumer	an organism that obtains energy and minerals by eating (consuming) other living things
decomposer	an organism that breaks down organic material. (All consumers fit this category, but it is sometimes used to refer to organisms that break organic material down completely and return the raw minerals to the environment)
detritivore	a living thing that eats wastes and living things that have died
ecology	the study of the inter-relationships among living things and between living things and their non-living surrounndings
ecologist	a scientist who studies ecology
ecosystem	the non-living surroundings and all living things (and their interactions) in a specific area
element	substance composed entirely of the same kind of atoms that can not be broken down by ordinary chemical means; there are 92 kinds of naturally occurring elements.
food chain	the pathway of energy and minerals from the non-living environment through living things
food web	all the interactions between the living things in an ecosystem that involve the exchange of energy and minerals
fossil fuel	the remains of once-living organisms that are burned to obtain energy, includes oil, natural gas, and coal
fungi	living things in the Kingdom Fungi, one of the 5 major groups of living things that includes mushrooms, yeasts, molds, fungi, lichens, and slime molds; all are detritivores characterized by their cell structure
herbivore	any living thing that eats producers (plants and algae)
heterotroph	a living thing that can not make its own food, but instead eats (consumes) other organisms
inorganic	any substance that was not formed by living things
interaction	when one thing affects another

interdependent	needing each other
living thing	any organized material that responds to the environment, moves, and is able to reproduce itself
minerals	any naturally occurring substance; may be a single element (nitrogen) or a compound (carbon dioxide, water)
monerans	organisms in the Kingdom Monera, one of the 5 kingdoms of living things thet includes bacteria and cyanobacteria (or blue-green algae); these microscopic organisms are characterized by the lack of all nuclei
mycorrhizae	fungi that live in or on the roots of plants and assist the plant in obtaining minerals from the soil
nitrogen	an element that is used in the formation of all living things
nitrogen-fixing	the change of nitrogen from a gaseous form into a form (ammonium) that can be dissolved in water
nitrify	the change of nitrogen in the form of ammonia into a form (ammonium) that can be dissolved in water
non-living	any thing which can not reproduce itself
omnivore	a living thing that eats producers and other consumers
organic	any compound containing carbon; any material formed by a living thing
organism	any living thing
phosphorus	an element that is needed by living things
photosynthesis	the process using the light energy in sunlight to convert water and carbon dioxide into carbon chains (sugar) and oxygen
plants	organisms in the Kingdom Plantae, one of the 5 kingdoms of living things that includes mosses, ferns, horsetails, conifers, and flowering plants; this group of organisms is characterized by having cell nuclei and cell walls, and a highly organized arrangement of cells; most can do photosynthesis and most are green; all, excepting mosses and liverworts, have a specialized system for transport of water and nutrients, including roots, stems, and leaves
producer	a living thing that makes food for itself and may be consumed by other organisms (plants and algae are examples of producers)
protists	organisms in the Kingdom Protista, one of the 5 major groups of living things that includes some microscopic living things (algae and protozoans) and kelp; organisms in this group are characterized by their cell structure which includes a nucleus, also by the lack of cell specialization for specific purposes
respiration	the opposite of photosynthesis; the process whereby sugar and oxygen are converted iinto water and carbon dioxide, with a release of energy
symbiosis	living together

SCIENCE WORD MYSTERIES

JR / SR HIGH

Name_____

Listed below are some word roots that willhelp you understand the meaning of many scientific words. Use these root clues to match the science words to their definitions. Then crack the code to find out what you are.

For Example:
Science word – phototropic
Greek roots – photo- light trop- turn, respond to
Meaning – to turn toward light

Science word – kilometer
Latin roots – kilo- 1,000 ; meter measure
Meaning – 1,000 meters

auto- self (Gr)
bio- life (Gr)
carn-- flesh (L)
com- together , with (L)
cycl- circle (Gr)
de-- away from (L)
duc- lead (L)
ec-house, environs (L)
en- in (Gr)
erg- work (Gr)
fungi-mushrooms
herb- green crop (L)
hetero-- unlike (Gr)l
in-- not
inter- between (L)
kine - movement (Gr)
log-- study, idea (Gr)
mensa-- table (L)
micro-- small (Gr)
mim-- imitate (Gr)
mutu--reciprocal ; vice-versa (L)
myc-- fungus (Gr)
omni- all (L)
organ- mechanical
ornith-- bird (Gr)
para-- beside (Gr)
pet-- seek, attack (L)
phot- light (Gr)
pro (prod)- before (Gr)
re-back again (L)
site- food (Gr)
scop- look at (Gr)
spir- to breath (L)
sume-- take away (L)
syn (sym) -- together
systema-- whole
the- put, place (Gr)
troph-- nourish (Gr)
vor--to eat (L)

Word endings: ---al to feed, support (L) -ist--someone who -ism-- indicates an action or condition -sis indicates a condition -y-- makes an abstract noun

1._____autotroph
2._____carnivore
3._____commensalism
4._____competition
5._____consumer
6._____cycle
7._____decomposer
8._____detritivore
9._____ecology
10._____ecologist
11._____ecosystem
12._____energy
13._____fungi
14._____herbivore
15._____heterotroph
16._____interdependent
17._____microscopic
18._____microbiology
19._____mutualism
20._____mycologist
21._____omnivore
22._____ornithology
23._____parasite
24._____inorganic
25._____producer
26._____photosynthesize
27._____respiration
28._____symbiotic

a. (seeking together) when two kinds of organisms seek the same, limited resource
b. (eating at the table to together) when two kinds of organisms live together and one benefits; the other is unaffected
c. (something that takes away together) an organism that gets energy by eating other living things
d. (circle) word used to describe the pathway of a mineral, or other material, that is used over and over
e. (study of the house) the study of the non-living environment, living things, and their interactions
f. someone who studies the non-living environment, living things, and their interactions
g. (not mechanical) non-living; not derived from living things; not containing carbon
h. a taxonomic group of organisms that includes fungi, mushrooms, slime molds, molds, and yeasts
i. (eating beside) an organism that lives in or on the organism it eats (or needs); the organism it lives in or on is harmed
j. (the whole house) the non-living environment, all the living things, and their interactions in a given area
k. (lead before) an organism that changes energy and, minerals into forms other organisms can use
l. (put light together) to combine light energy with water and carbon dioxide to produce oxygen and sugar
m. (breathe out) the conversion of oxygen and sugar into energy, water, and carbon dioxide; the latter is breathed out
n. (living together) when two kinds of organisms live with, or depend upon one another
o. (in work) capacity to do work
p. (to eat detritus) an organism that eats dead things and waste materials, i.e. detritus
q. (put away/from together) an organism that breaks down organic material into minerals
r. (state of eating reciprocally) when two kinds of organisms help each other
s. someone who studies fungi
t. (flesh eater) an organism that eats other consumers, (or meat)
u. (to eat all) an organism that eats all kinds of things
v. the study of birds
w. an organism that eats producers, such as plants or algae
x. (other nourish) an organism that feeds on other organisms
y. the study of very small living things
z. (dependent between) relying on or needing each other
aa. (self nourish) an organism that can make its own food
bb. too small to see

20	21	8	9	19	9	5	12	26	12	24	18	14	12	19	6	6	9	2	9	5	2	23	22	9

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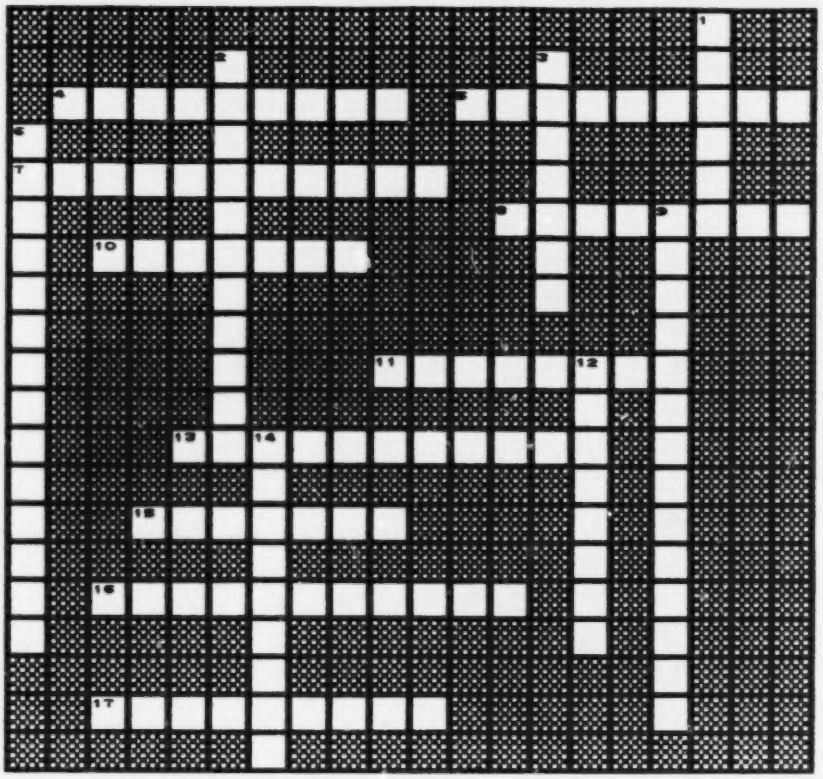
Ecology Crossword

Name _____



ACROSS CLUES

4. the non-living environment and all living things, and their interactions, in a specific area
5. the pathway of energy and minerals from the non-living environment through living things and back
7. a living thing that cannot make its own food, but instead consumes other organisms
8. a group of living things which lack specialized cells, but have cell nuclei, such as protozoans and algae
10. the change of nitrogen in the form of ammonia into a form that can be dissolved in water
11. a living thing that makes food for itself from its non-living surroundings
13. the opposite of photosynthesis; the process where sugar and oxygen are converted into water and carbon dioxide, with a release of energy
15. a group of living things that are characterized by their highly organized, multicellular structure; and are consumers
16. a living thing that eats wastes and dead organisms
17. a living thing that eats producers

DOWN CLUES

1. a group of living things that are characterized by being capable of photosynthesis, and having specialized body parts
2. fungi that live in or on roots of plants and assist the plant in obtaining minerals from the soil
3. a group of microscopic living things with genetic material not stored in a nucleus, such as bacteria
6. the process that uses sunlight to convert water and carbon dioxide into carbon chains (sugars) and oxygen
9. needing each other
12. an organism that obtains energy and minerals by eating other living things
14. living together

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Come forth into the light of things, let Nature be your teacher.

William Wordsworth

Lesson 1.

Students will be able to name several examples of living and non-living things, and identify differences and similarities between living and non-living things.

Background. All ecosystems include the non-living surroundings and living things. Our non-living surroundings are made up of the 92 elements and energy in a variety of forms. Air, water, rocks, and dirt are examples of non-living things made of elements. The earth's air consists of 78% nitrogen, 21% oxygen, 0.9% rare gases, 0.03% carbon dioxide, and very small but varied amounts of water vapour, dust, bacteria, pollen, etc. Water is made of hydrogen and oxygen combined. It is a very important for a variety of reasons, but especially because more substances can be dissolved in water than in any other liq uid. Rocks are composed of a wide variety of elements; silicon, oxygen, aluminum and iron are by far the most common. Dirt is mainly powdered rock and thus is also made of a wide variety of elements. Energy is present in non-living surroundings in a variety of forms, including sunlight, heat, electricity (static and lightening), motion (or kinetic), and stored in chemical compounds--that is, stored in the bonds between molecules.

Living things are also made up of elements and energy. The most common elements in living things are the hydrogen, oxygen, carbon, nitrogen, phosphorus, and sulfer. Other elements occur in lesser amounts. Energy is present in living things as electricity, heat, and motion and stored in compounds. Living things are differentiated from non-living things by their abilities to move (in response to their environment), grow, and reproduce themselves. Some scientists estimate that over 5 million different kinds of living things occur on earth. The two most familiar groups of living things include plants and animals. These were once considered the only groups of living organisms. While scientists are still debating about classification of living things, the following five groups are those currently accepted: plants, animals, fungi (includes lichens), protists [includes single-celled organisms and most algae (includes seaweed)], and monerans (includes blue-green algae (or cyanobacterium) and bacteria). For the purposes of this unit, students should learn to recognize some of the organisms in each of the 5 groups. See p. 93 and the living things poster for more information about the 5 groups.

Vocabulary: *animals,ecosystem, elements, energy, fungi, living, monerans, non-living, plants, protists.*

Introductory Activity.

Objectives:

1. Students will practice listening, memory, visualization, and classification skills.
2. Students will be able to identify the living and non-living components of an ecosystem.

Materials:

Alaska Wildlife Week posters, photos of several natural areas

Procedure:

1. Most students spend a lot of time outdoors and may already be familiar with a variety of living and non-living things. This excercise will help them to think of the non-living and living things they are already familiar with and encourage them to look for additional kinds. Ask students to close their eyes, listen carefully, and imagine themselves in a wild area nearby. Ask them to imagine that they have extraordinary senses and can see and feel everything that is going on around them. Explain that you will read a few lines to get them thinking, but then they will continue their walks by using their imaginations. Read the following passage aloud to the class.

What a beautiful day to spend in an ecosystem. The sky is filled with big fluffy clouds. Still, the sun is shining through one big patch of blue. The sunshine feels warm on my coat, but the air is still a little chilly. Most of the winter snow has melted. The ground is wet and muddy. High overhead, a flock of geese honk wildly. They are heading north with the spring. I have the whole day to enjoy this ecosystem. I wonder what I will find....

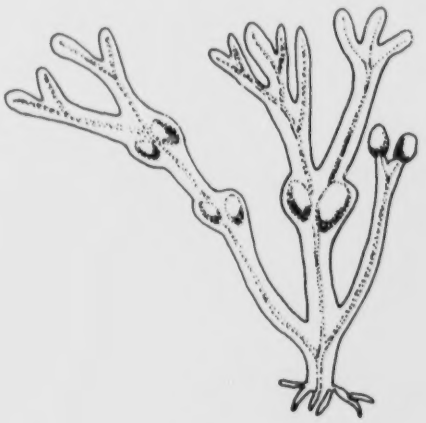
Alaska Wildlife Week Unit 4. © 1985 ADF&G

2. Wait a few minutes. Then,have students write a paragraph describing everything they saw, felt, and heard happening in the wild area. Then have a few students read their paragraphs. List on the board the realistic things that students observed. Have every student contribute to the list. If students listened carefully, the list should include sunshine, clouds, water, snow, and geese. They may also have visualized plants, animals, people, or other items. (Note whether any students visualized any interactions between the living things.)

3. Use a few of the items as examples of living and non-living things. Help students to figure out the differences between these, stressing the importance of organized structure, ability to move and respond, and self-reproduction as characteristics of living things. Have students divide the original list into two lists--living and non-living things.

Then, use the Alaska Wildlife Week Non-Living Environment and Living Things posters to identify a wider variety of non-living and living things. Discuss each of the 5 groups of living things. How many of these organisms did students visualize on their walk? Which ones did they not visualize (insects, microscopic living things, fungi)? Have students try to think of representatives of each that occur in your area. Add to the class list any of the kinds of living things shown on the poster that students have seen, or think occur in the ecosystem around your school. (Challenge students to try to find more examples of each group during the coming week--perhaps they could set up a display of pictures (or drawings) of living things found in your area.)

4. Next, review again the differences between living and non-living things, then ask students what similarities exist, if any. Encourage them to think of what both are made up of--they should already be familiar with molecules and atoms and may recognize that both living and non-living things are made of these. Show students a periodic chart of the elements and explain that all things scientists have so far examined--from the earth to stars--including living things-- are made up of the same 92 elements. Actually, most of the elements are fairly uncommon in both non-living and living things. Discuss which elements make up the air, water, rocks and soil, and which largely make up living things (see background and posters). Do students recognize thatboth non-living and living things are largely made up of the same elements?



Next, ask students if they can think of anything that is not made of elements. Prompt them to think of electricity, heat, light, motion----i.e. energy. Define energy as the capacity to do work (or change something). Have students think of examples of energy found in the non-living environment (light, lightening, wind, fire, heat, etc.) Then ask for examples of energy in living things--movement (both movement of body fluids and body parts), heat, light (firefly), electricity (electric eels).

Re-iterate that non-living things and living things are made up of the same basic building blocks--elements and energy. Review the differences again.

5. Go back to the lists of living and non-living things. Ask students if they remember the name of the place they "walked" through. Do any students remember the word, "ecosystem"? Explain that ecosystem is a word that describes all the living and non-living things that occur in an area, and their interactions. The two lists they made up show just some of the parts of the ecosystem around them. Show the examples of other Alaskan ecosystems on the Ecosystem Poster. What do each of these ecosystems include? (the non-living surroundings and living things.)

6. Several activities that build on this lesson are given on the following pages. Be sure to have students work the Ecosystems Worksheet following this lesson; it can be used as an evaluation of student understanding.

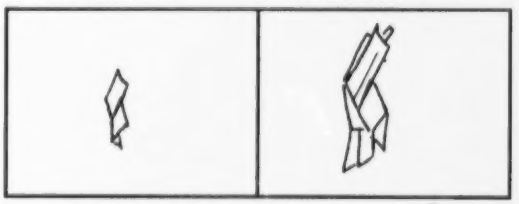
ECOSYSTEMS WORKSHEET Name_____

A scientist made the following observations of 4 unknown items. The later observations were made over a long period of time. Based on thesee observations, which of the following would you conclude is (a) living, which is probably (c) non-living, and for which do you have (e) insufficient evidence to decide.

1st Observation Later Observation

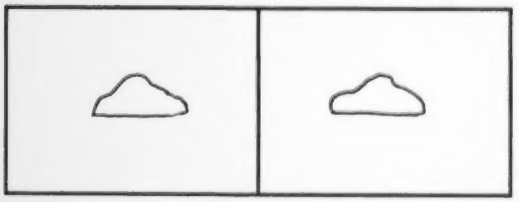
1.____

1st Observation Later Observation



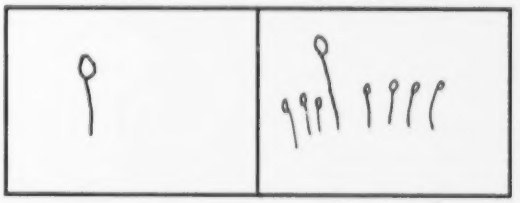
2.____

1st Observation Later Observation



3.____

1st Observation Later Observation

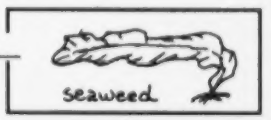


4.____

Match the living things below to their kingdom: g) moneran l) protist n) fungi o) plant s) animal

5.____

8.____

11.____ 

6.____

9.____

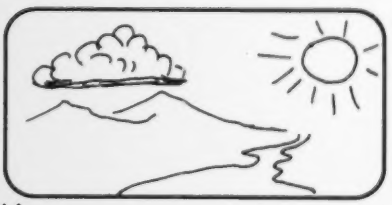
12.____

7.____

10.____

13.____

Which of the following could be considered an ecosystem? i) no t) yes



14.____

15.____

16.____

Now match the letters of your answers to each numbered questions to crack this code and find out what you are becoming: 1-9 2-3-10-11-6-12-14-13-15

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Activity Ideas for Curriculum Integration

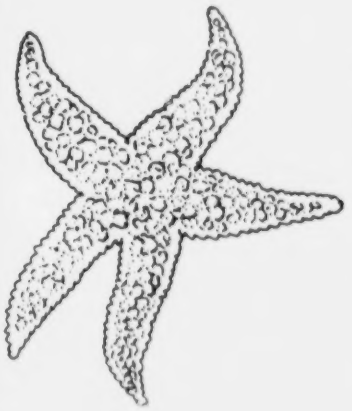
ART SCIENCE

Objectives: Students will become more familiar with the non-living and living things that make up ecosystems and be able to classify them.

Materials: Old magazines and/or books that deal with science, nature, or wildlife; index cards; or xerox copies of the drawings on the poster.

Procedure: (This step may be done in class, as homework, or as preparation by the teacher) Have students go through the resource materials looking for photos of living and non-living things. Ask students to cut out pictures (or use the photos as references to draw pictures) of living and non-living things that occur in ecosystems. Each individual is to locate at least one picture of a non-living thing and a representative of each major group of living things, i.e. monerans, protists, fungi, plants, and animals. Have students draw (or paste) their pictures on to separate index cards. Each student should make 6 cards, with each card showing just one living or non-living thing. Have students write the name of the pictured item on each card.

Shuffle all the cards together. This game may be played in groups or individually. Explain that the object of the game is to get rid of all their cards. They do that by correctly classifying the item pictured. You will call out a category, non-living, or living thing--moneran, protist, fungi, plant, or animal. If a group has a card that fits the category, they hold it up. If their classification is correct, they may discard the card to a central pile. If their classification is wrong, they have to draw another card from the pile and they can't discard. First student or group to get rid of all their cards wins.



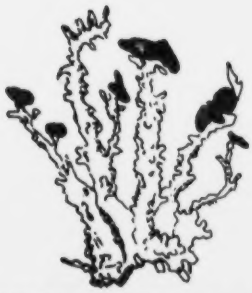
LANGUAGE ARTS SCIENCE

Objectives: Students will practice classification and recognition of the 5 major groups of living things.

Materials: Alaska Wildlife Week Living things poster, one photocopy of the enclosed Living Things Classification workshee t (p. 14) for each student in the class, plus one copy that is cut up, crayons or felt-tip markers, paste, construction paper, bingo markers (such as beans or pennies).

Procedure: Review the variety of living things using the Living Things poster. Give each student a copy of the Living Things Classification Worksheet. Have them color in the organisms and cut up this sheet so that each pictured organism is on a separate piece of paper, and each of the 5 categories is on a separate square of paper. Then, have each student reconstruct their own unique bingo card by pasting all the headings on a sheet of construction paper in the order of their choice. Then have them classify and paste each of the pictured organisms under the proper category. They can use the poster to help figure out which category each organism should be placed in. When all the students are finished, each will have a unique bingo card. Pass out the bingo markers. Place the squares of the cut up bingo card in a jar and select one student to be a caller. The caller reaches into the jar and pulls out a card. They then decide which category it should be in and call out the category and the name of the organism. (Encourage the class to correct the caller if he/she classifys any organism incorrectly.) Students then place a marker over that organism on their card. Repeat until one student has 5 in a row (up, down, or diagonally). Then, that student becomes the caller for a new round.

SOCIAL STUDIES



Objectives: Students will recognize that the ecosystems around the world have the same basic components (living and non-living things), but are different because of the interactions of these components.

Materials: Photos or slides of wild areas around the world, reference materials about wildlife and the environment of two contrasting areas (preferably your area and some very different one).

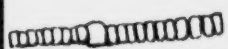
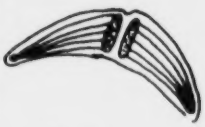
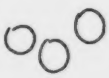
Procedure: Show the photos to the class. Identify the locations where the photos were taken on a world map or globe. Then have students look carefully at all the photos. Have students compare the photos and decide what the areas have in common (air, water, soil, sun, plants, animals, etc.)? Students should quickly realize that the same kinds of living and non-living things are found all over the world. Have them guess whether or not they might find other similarities if they visited the areas. Would they all have insects? Microscopic living things? Fungi?

Next, have students carefully compare the wildife of two different environments (your region and a desert, or the tropics). You may want to have the class divide into groups and work on comparing particular groups of organisms--birds, mammals, fish, invertebrates, etc., or choose a specific group--rodents, hawks, frogs, etc. Have students research the similarities and differences in the groups in the two different regions. They should look at the number and variety of species, their physical appearances (color, size, shape (appendages), food habits, habitat preferences, timing of breeding, and number of young produced per year. Can students find any trends or make any generalities about the differences in the living things found in the different environments? If so, have students hypothesize why such differences exist and try to think of a way to test their hypotheses. By careful study, scientists have found some general trends--for example, northern (cold climate) animals tend to be larger, darker, have smaller appendages, and produce young later in the calender year, than their southern (warm climate) counterparts. (See the 1984 Alaska Wildlife Week Teacher's Guide for information on adaptations of organisms to aquatic environments.)

Alternative Approach 1: Discuss and examine some of the adaptations of animals to the arctic--then have students predict the kind of adaptations animals that live in a desert or tropical forest might have.

Alternative Approach 2: Locate a teacher and class in a different part of Alaska, the Lower 49, or the elsewhere in the world that would be willing to study the ecosystem of their area and then exchange observations with your class.

LIVING THINGS BINGO

MONERANS	PROTISTS	FUNGI	PLANTS	ANIMALS
 Blue-green Algae (Cyanobacteria)	 Algae	Mushrooms	Mosses	Arthropods
Spirochete Bacteria	Slime Molds	Morel	Ferns	Mammals
Rod-shaped bacteria	Phytoplankton	Lichens	Horsetails	Birds
Filamentous Bacteria	Seaweeds or Kelp	Shelf Fungi	Conifers	Fish
 Bacteria	Protozoans	Molds	Angiosperms	Worms

SCIENCE

JR. SR. HIGH LESSON 1

Objectives: Students will be able to identify some of the differences between living and non-living things, and describe some experiments to determine whether an object is living or not.

Materials: A variety of living and non-living things: a jar of water, a jar of air, soil, a rock, a ray of sunlight (if possible), a wind-up toy, a group of rocks-2 large and several small, sugar crystals (a jar of water with sugar dissolved in it and a string--allow to set for a day prior to class) a small bird or mammal, several different live insects and/or other invertebrates (such as flat worms, a clam, or other), microscopic organisms, yeast, bread mold, spores from a fern or mushroom, and some kind of plant seeds. Try to include at least some small living things with which your students are not familiar. Provide students with microscopes, hand lenses, and other equipment as available.

Procedure: The purpose of this activity is to reinforce student knowledge of the differences and similarities between living and non-living things, but more importantly to encourage them to think and question by providing examples of items that are not easily classified. Place the above materials at different numbered stations around the room. Discuss and review the differences between living and non-living things (abilities to respond to stimuli, move, change, and reproduce). Then explain that students are to imagine themselves as scientists from another planet; their explorers brought back the items that are around the room from the planet Earth. As scientists, they are to determine which of the objects, if any, are living and which are non-living. They must describe the tests they conducted to determine which items were alive. They may also conclude that further tests are needed--but they should then describe what further tests they want to conduct.

Have students work in groups or individually. After they have time to visit each station, have the" scientists" report their conclusions regarding each item. Record the class votes for living and non-living for each item. Select individual students to explain why their group classified the item as living or non-living. What tests did they conduct and what were the results? Encourage students to think of other tests they might conduct to better determine the classification of the items. If necessary, prompt students to think ofobserving the questionable objects over time to see if they grow, change, or reproduce. Leave the stations set up so students can compare the items over time. Do further observations change any opinions about the classification of the various items? In the end, reveal the actual classification of the items, and discuss any discrepancies between the class conclusions and the facts. You may want to grow the seeds and the spores to prove they are alive, but needed to be placed in the proper environment in order to grow. (Grow spores on agar medium. You can mix your own with one package of unflavored gelatin, 1 1/2 tablespoons of malt (kind used to make milk shakes), and 1 quart of water.)

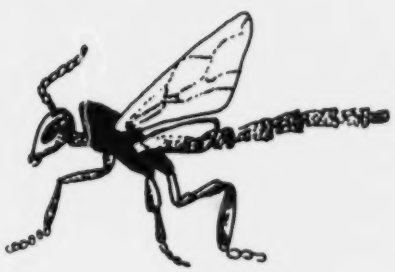
Extension--Have interested students do an extra credit report on the tests done by scientists to find out whether there was life on the moon or on Mars. If possible, have them present their findings as an oral report to the class.

MATH

JR SR HIGH LESSON

Objectives: Students will be able to compare the abundance of various organisms based on measurements of the number observed per unit area and will realizethe abundance of living things, especially microscopic organisms.

Procedure: Prior to doing the Ecosystem Investigation activity, hold a contest in your class for students to guess how many living things occur in a 100 square meter wild area near your school. Then, have students do theEcosystem Investigation Activity (p 19-27) including the measurements of abundance as described on the Ecosystem Investigation woksheets. (Or you could get these measurements from another class that did the above activity). First compile the data on each group of organisms from all the different groups, and average (or have the class average) the numbers for each major group to get an estimate of the abundance (density) of living things in each group. Then, ask students to rank the organisms in order of abundance. In order to do this they will need to calculate the number of each, per standard unit of area. You may assign a specific unit of area (for example, number / square meter or number / 100 square meters) to make it easier to check student calculations. Calculate the abundance of soil and water organisms based on the volume of soil or water in the defined area (assuming a 15 cm (6 in) depth). Have students estimate the number of living things in a 100 square meters using these standardized measurements of abundance. Whose original guess was closest to the class estimate? Hold a contest for the rest of the school to guess how many living things your class found in a 100 square meter area. Discuss the class's estimate. Do students think their observations are accurate? How do the abundances they calculated compare to scientists' estimates? (From 100,000 to 2.5 billion monerans in a gram of soil--that is about equal to 1 cubic centimeter) Why might student estimates of abundance for microscopic organisms be low? (Student microscopes are not as powerful as those used by scientists; students also likely took less precise observations and measurements of numbers, soil samples).



ECOSYSTEM INVESTIGATION--SCIENCE

Suggestions for Studying an Ecosystem Around Your School

Objectives: Students will make observations of the non-living surroundings and living things and will recognize that these affect each other (i.e. the non-living environment influences living things; living things influence the non-living environment.)

Materials: Two accessible outdoor sites that differ in some environmental factor (soil type, water availabity, dominant vegetation type, north and south facing hillsides) or one site with a gradient of microenvironments (a beach). Paper and pencils. The specific equipment as described on the Ecosystem Investigation worksheets (see following pages). These include: in the field (per group)-- a thermometer, 4 vials, a can for taking a soil sample, 1 plastic bag, a 1 m and a 10 m length of string; a petri dish with agar (for growing fungi spores), a plankton net and/or a kick net (see illustrations). Optional--binoculars or spotting scope, hand lenses, light meter (in a camera), Hoch Water Test Kit. In the classroom - following the field study: a microscope; a light, funnel, and narrow-necked flask (1 per group--see illustration re: soil organisms), a warm moist place.

If you do not have some of the required equipment, improvize or have students skip whatever they can't do. Be sure they get to look at each worksheet though.

Procedure: Review the variety of living things using the poster. Ask students how many of the different kinds of living things they thinkoccur in your area? Discuss each kingdom--monerans, protists, fungi, plants, and animals separately. Have students guess whether or not they could find these organisms in their area; how many different kinds of organisms (from each group)occur, (if any); and which kinds are the most and least abundant. Record their answers. Would students expect to find any differences between a wet and dry site (or other variable)? If so, what differrences do they expect; record these.

Challenge students to try to find out how accurate their guesses were. What living things really do occur in your area? What differences are there between a wet and dry site (or other varible). What would be the best way to find out? Try to have students come up with the idea of going outside to look.

As a class, choose two different nearby areas (or one varied area) to examine closely. Divide the class into groups and have each group make an ecosystem booklet based on their observations and studies of the areas chosen. You can determine the number of groups studying each area based on the size of your class and the group size in which they are likely to work best. If you have one site with a gradient, you can have the different groups set up their observation sites along a transect from one extreme of the gradient to the other.Each group's booklet should have at least 6 pages (the worksheet on the non-living environment of the site, and one summary sheet with drawings and measures of abundance for each kingdom of living things.) Encourage students to use field guides to try to identify some of the living things they find.

Have students use the suggestions in the Ecosystem Investigation worksheets to help them in finding out what living things occur (see following pages). Before going out on the field trip, have students read through the worksheets. Before or after the field trip, they may want to talk to microbiologists about how to find monerans and protists, or talk to a wildlife biologist about reading animal sign, or setting small animal live traps. Or they may want to read books about the various organisms, what they do, where they live, etc. and try to figure out how to look for them.

Discuss how the lists of living things discovered by the class compare to the list of living things the class expected-- in numbers, variety , and abundances? Were their predictions regarding the differences in the two environments correct? Are they surprised by anything?

Then have students compare the two areas, or transect observations, and note similarities and differences. If more than one group studied each area, be sure to average their observations and discuss any variations.

If the groups worked along a gradient, don't miss the opportunity to have students make graphs of at least some measurements (temperature, numbers of various organisms) against the gradient variable. Then have them hypothesize why these differences might exist. Why was one site warmer than the others--was itdue to lack of plant cover, shading by a mountain, or some other reason. Do students come to the conclusion that the non-living environment and living things affect each other in a variety of ways?

Suggested Evaluation: Have students write an essay to tell others about the living things of your area. Do they write about all the different groups of living things?

An alternative: Have individual students select an area and use all the ecosystem investigation worksheets. This could be a term project.

ECOSYSTEM INVESTIGATION--NON-LIVING ENVIRONMENT

Look at the site you are studying. What non-living things do you notice immediately?

_____

INVESTIGATING THE SOIL---Dig a small hole in the ground so that you can see a cross-section of the soil 30 cm (about12 inches) deep. Does the soil have any layers that look different in color or texture? ____ Draw a picture of the layers. Do any of the layers have ice in them?_____ Do you think you would find ice if you dug deeper?_____ How thick is the top layer of soil?

Look at the soil color carefully. Soil color tells much about the make-up of the soil. The more organic matter in the soil, the darker brown or black it is. Large amounts of iron will make the soil appear reddish or orange, while large amounts of copper will give it a greenish tint. Record the color of each of the soil layers on your drawing. Which one is darkest? Why do you think that might be?
Soil texture: Wet a sample of soil from the top layer and rub it between your fingers. How does it feel? Grainy? Spongy? Slippery? If it fels grainy, it has a lot of sand in it. If it feels spongy, it has a lot of organic material. If it feels slippery it is a clay soil. Record the texture of soil from each layer.

Feel the soil to see how moist it is. Which layer feels the most wet? _____How does soil moisture change with soil depth?_____ In part, the amount of water in the soil dependson how recently it rained or the snow melted, but the make-up of the soil is also very important. Soils with a lot of organic matter hold more water than soils without organic matter. Clay soils also hold a lot of water, but they bind it so tightly that most plants can not use it. Plants have to have water to absorb minerals from the soil. What kind of soil do you think plants would grow best in-- a soil rich in organic material, a sandy soil, or a clay soil? _____

INVESTIGATING THE AIR--Do you note any color to the air when you look at the horizon? Is it clear, smoky, or dirty?_____ Describe anything you smell in the air. _____
The amount of nitrogen, oxygen, carbon dioxide, and other gases in the air are impossible to measure unless you have very sophisticated equipment. However, a simple test will show how much dust and pollen are in the air. Spread petroleum jelly on several cards then place them in a variety of places (on a tree, building, near the ground, along a road). Leave the cards out for a day. Then examine the cards carefully. Is there any dust in the air? What sites had the most?_____

INVESTIGATING THE WATER-- Are there any ponds, lakes, or streams in the ecosystem you are examining? What percent of the ground do these cover?_____
Is there any ice or snow? What percent of the ground do these cover?_____

INVESTIGATING THE ENERGY--You can find out roughly the amount of light energy in a particular location by holding up a solid object (such as a book) and noting the kind of shadow it casts. If the shadow is sharply defined, there is a lot of light. If the shadow is hard to see, there is a moderate amount of light. If you can't see any shadow, there is little light. (If you have a light meter (or a camera with a light meter) you can take a measurement of the amount of light. What is the light level in the area you are examining?
Bright Moderate Low
Are the light levels the same everywhere? (on the ground, 10 inches up, 10 feet up, 100 feet up? Under a tree? Out in the open?_____ Where are light levels lowest?_____ Where are they brightest?_____ Plants need light in order to live and grow. Do you see any evidence that the amount of light affects plants?

_____
(Are there the same numbers and kinds of plants in low light level areas as in areas with high light levels? How do the number, size and shape of the leaves in these two sites compare?)

Another measurement of energy can be taken with a thermometer. This is a measure of the heat energy in the environment. Although living things can not convert heat energy, temperature affects living things in many ways.

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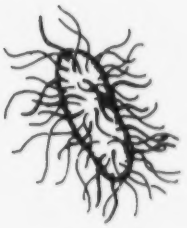
ECOSYSTEM INVESTIGATION--Monerans and Protists

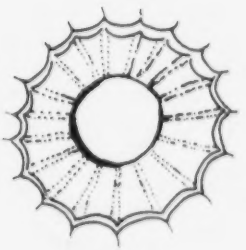
LOOK FOR SIGNS--All individual monerans and many protists are microscopic, but en masse, it is possible to see some kinds. A scum on the surface of the water is a good sign that bacteria or blue green algae (or cyanobacterium) are present. A greenish or brownish slimy coating on an old log or on a rock is evidence of cyanobacterium or algae. Many bacteria help to decay dead leaves. Look for a dead leaf that has decayed so that all that is left is a fine meshwork of veins. That is evidence of bacteria at work. Make a list of the evidence of bacteria and protists that you find.

LOOK FOR THE ORGANISMS--In order to see microscopic organisms, you need to use a microscope. Collect samples of soil, water, moss, tree bark, and dead leaves. Place a tiny bit of each one on a microscope slide, and add a drop of water. Examine the slide under high power. Can you see anything that looks like any of the diagrams on the poster? Decide which group each likely belongs to. (Some are nearly impossible to classify unless you have a powerful electron microscope.) Draw pictures of these microscopic organisms in your booklet on the appropriate pages.

ASK EXPERTS--A microbiologist is a scientist who studies microscopic living things. You might find one at a university, offices of the State of Alaska Dept. of Environmental Conservation, or U.S. Environmental Protection Agency, or local health service. You could ask them about the bacteria, cyanobacterium, algae and other protists of your area. They might have pictures or samples of some they could show you.



HOW ABUNDANT ARE THEY-- Count the number of organisms on each slide you prepared and record this. Consider how many slides of each material you could make from a tablespoon of that material . (You could measure out a tablespoon of soil and find out how many slides you could make out of it.) Multiply the number of monerans and protists on a single slide times the number of slide samples in a tablespoon to estimate how many microscopic organisms are in a tablespoon of soil.



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ECOSYSTEM INVESTIGATION--Fungi

LOOK FOR SIGNS--Most fungi help to decay or rot dead organisms and waste materials. Look for evidence that a log is decaying, or leaves are rotting away. Record any evidence of fungi that you see.

LOOK FOR THE ORGANISMS--You are likely to find fungi anywhere that dead plants are found. They are more likely to be growing in a moist spot. Look for old dead trees. Examine an old log carefully. Dig into the leaf litter on the ground. You are looking for anything that is spongy (mushrooms and shelf fungus), that looks like dust (a mold), or like a clear or milky jelly (a slime mold). Examine any that you find with a hand lens. If you find a mushroom or a shelf fungus, look at it carefully; try to find out what it is growing on and if it has any parts hidden from view. A special type of fungi grow together with certain algae and cyanobacterium to form lichens. These can be found just about anywhere. Look for them on the surface of rocks, on tree branches, and on the ground. An easy way to recognize a lichen is that it is brittle and easy to break if it is dry, but will gradually become flexible if you wet it. Draw pictures of each of the kinds of fungi that you find.

TRY TO GROW SOME FUNGI--Many kinds of fungi are hard to find except during certain seasons when they send out fruiting parts that produce their spores. A mushroom is an example of a fruiting part of a fungi. The fungi is there growing underground all year round but you may only see mushrooms in late summer. You may be able to grow some of the fungal spores that are around by making a fungi garden (see the diagram below). Let the fungi garden set for a day so that spores in the air can fall into it. Then put your "fungi garden " garden plot in a moist warm place and see if anything grows.

ASK EXPERTS--A mycologist is someone who studies fungi. You might find a mycologist at a local university.

HOW ABUNDANT ARE THEY? Count the number of fungi that you can see in a 50 cm square area. (Since some fungi may only be found in certain seasons, you might want to come back and take the same measurement at different times of year.)

HOW TO
MAKE A FUNGI GARDEN

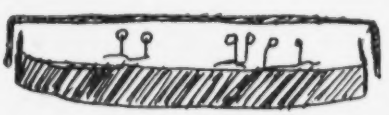
1. Mix up a growing medium. Boil 1 quart of water. Add 1 1/2 tablespoons of malt and 1 package of unflavored gelatin. Stir constantly until mixture boils. Boil 1 minute.

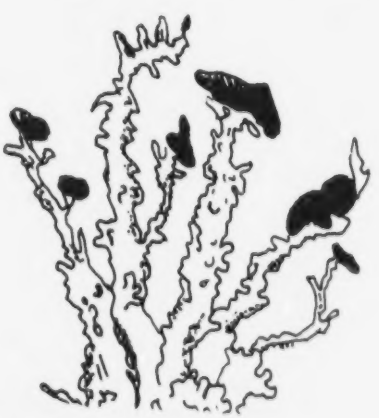
2. Pour into jar or dish. Cover well with plastic and let sit until mixture gels.

3. Set the dish of growing medium out in your plot. Remove the cover and leave it for 24 hours.

4. Replace the plastic cover.

5. Place the entire unit in a warm moist place and observe what happens during the next week.





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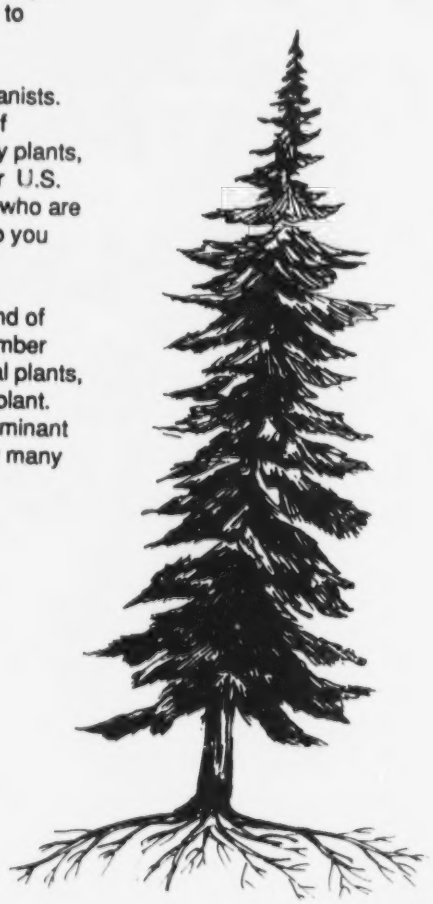
ECOSYSTEM INVESTIGATION--Plants

LOOK FOR SIGNS--Depending on the time of year and where you are, many plants may be dormant--so you won't see their leaves, flowers, or even stems. You might find it interesting to find out what plants are in the soil as seeds. Take a small sample of soil back to the classroom, or collect a variety of seeds from the ground and take them along with the soil. Put the soil in an open container (an old milk carton, for example). Then, water the soil well, cover it with plastic and place it in a sunny spot. Watch your mystery garden closely for 2-3 weeks and record what happens.

LOOK FOR THE ORGANISMS--Plants are probably the easiest living things to observe and study. You can see them easily and they can't move away. But it is easy to overlook the number and variety of plants unless you look carefully. Be sure to look for mosses, ferns, and horsetails as well as conifers and flowering plants (see the poster if you don't know what these are). How many different kinds of plants can you find in a 1m x 1m area. Draw pictures of each of the plants you find. Be sure to notice the edge of the leaves and their shape. Try to identify the most common plants by using a field guide to plants.

ASK EXPERTS--Scientists who study plants are called botanists. You can find botanists at universities and at the State Dept. of Forestry and U.S. Forest Service. Most biologists can identify plants, so you might check with the Alaska Dept. of Fish and Game or U.S. Forest Service for help. Local nature clubs may have people who are interested in, or study plants, too. They might be able to help you identify some of your plants.

HOW ABUNDANT ARE THEY-- Count the number of each kind of plant that you found in your 1 m x 1 m area and record this number next to the drawing of that plant. Be careful to count individual plants, not every individual leaf or stem. Count a moss clump as one plant. Which plants are the most abundant. These are called the dominant plants. Add all the numbers of plants together to find out how many plants were in your 1m square area. Record your answer.



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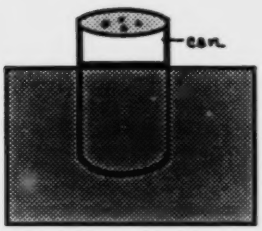
LOOK FOR SIGNS--Many kinds of animals, including insects, snails, spiders, isopods, and small mammals live underground. If you just glance at an area you may not notice they are present. Examine your 1m x 1m area carefully. Look for small holes or tunnels into the ground, droppings, or leaves that seem to have a bite taken out by a small animal. Record any evidence of animals that you find.

LOOK FOR THE ORGANISMS--Use an empty can as a sampling tool. Press the open end into the soil until the can is at least half full of soil. Mark the can so you will know later how much soil you collected. Take the soil back to the classroom in a plastic bag. You can place it in a tray and sort through it. Or, set up the Berlyse funnel shown on the right. Leave the light on overnight. Many of the living things in the soil will move away from the warm bright light and fall into the collecting bottle. Draw pictures of the organisms you find. Can you identify any of them? Compare them to drawings on the poster.

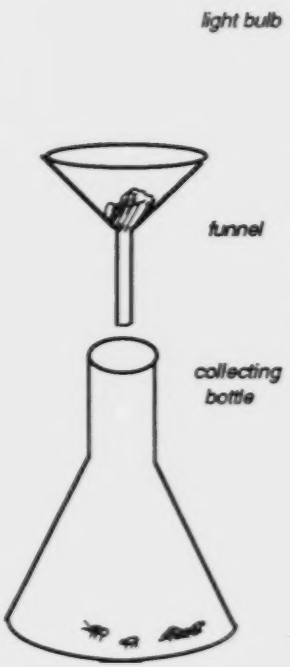
ASK EXPERTS--An invertebrate biologist is a scientist who studies animals that do not have backbones (like insects, mollusks, crustaceans, and worms). Entomologists are scientists who study insects. Either of these kinds of scientists could probably tell you some of the organisms that are found in the soil and they might be willing to help you identify the ones you find. You might find such a scientist at a local university, an office of the U.S. Dept. of Agriculture (includes the U.S. Forest Service), or the State of Alaska, Division of Agriculture.

HOW ABUNDANT ARE THEY? 1. Find out how much soil you collected. (Fill your sampling can up with water to the same level as the soil sample. Measure how much water this is in milliliters using a graduated cylinder.) One milliliter equals 1 cubic centimeter. 2. Count the number of organisms you found in the sample. By dividing this number by the number of cubic centimeters of soil you sampled, you can find out how many soil organisms there are per cubic centimeter. Record this in your ecosystem book.

Soil Sampler



Berlyse Funnel



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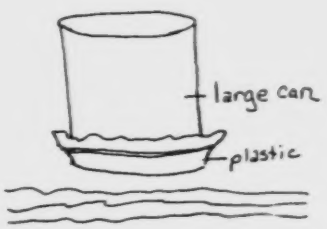
ECOSYSTEM INVESTIGATION--Animals in the Water

LOOK FOR THE ORGANISMS--You can make the underwater viewer shown at right with a coffee can and some clear plastic. Put it on the water surface and look under water for fish, insect larvae, worms, or other creatures. Pick up rocks and look on the underside of them. (Be sure to put them back in the same place so the animals that live there will still have their home.)

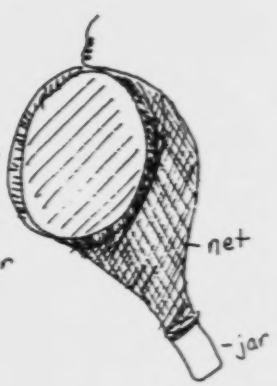
CATCH THE ORGANISMS--The diagrams below show a variety of ways that you can catch animals that live underwater in order to look at them more closely. Be sure to return them to their homes after examining them. Check your library for books on identifying insects and other invertebrates.

ASK EXPERTS-- You can find fisheries biologists at your local Alaska Dept. of Fish and Game or U.S. Fish and Wildlife Service office. Since fish eat the other kinds of living things in the water, fisheries biologists will likely be able to help you identify the insects and other invertebrates, too.

MEASURING THE ABUNDANCE OF AQUATIC INVERTEBRATES--Measure the volume of water, or bottom sediment that you collected. Then, count the number of organisms in the sample. You might also count the number of organisms found per rock examined. Record the number of organisms located per unit area.

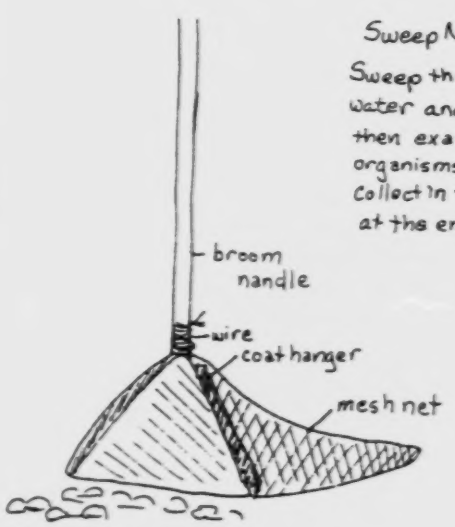


Underwater Viewer



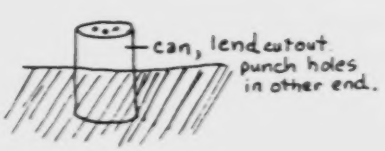
Sweep Net

Sweep through water and then examine organisms that collect in the jar at the end.



Kick Sampler

Place on bottom of a stream. Kick stream bottom gently. Examine.



Core Sampler

Push down into bottom of stream or pond, then pull up. Sort through sample.

*Check the 1984 Alaska Wildlife Week, Unit 2. Water, Wetlands, and Wildlife for more information and instructions on making and using some of the above sampling equipment.

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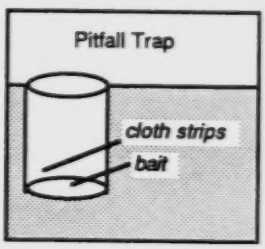
LOOK FOR SIGNS--Often, it isn't easy to see the birds and mammals that live in an area. Many move around over large areas and try to stay hidden. But they leave signs of their presence. Look for animal droppings, tracks, hair or feathers, plants that have been nipped or browsed, nests or dens. A book that will help you identify animal sign is A Field Guide to Animal Tracks by Olaus J. Murie. Record any evidence of birds or mammals that you find.

LOOK FOR THE ORGANISMS--The most important thing to remember when you are looking for birds and mammals is to be quiet--talking and moving around noisily will scare them away. Sit quietly, listen and watch. Try to visit the site in early morning or late evening. Bring binoculars or a spotting scope, if you can. Draw pictures or make a list of all the birds and mammals you see.

ASK EXPERTS--Wildlife biologists study birds and mammals. An ornithologist studies birds and a mammalogist studies mammals. You might find these kinds of scientists at your local Alaska Dept. of Fish and Game or U.S. Fish and Wildlife Service office. Or, check with local nature clubs; members of organizations like the Audubon Society may know a lot about the birds and mammals of your area. Sportsmen's groups are also a good source of information; trappers and hunters may know a lot about some of the mammals in the area. State and federal park departments may also have biologists or naturalists on their staff.

CHECK REFERENCES--A good way to find out more about the wildlife in your area is to check books about wildlife, like the Guide to Birds of Alaska by R.W. Armstrong, and A Guide to the Mammals of North America by Burt and Grossenheider. Make a list of the birds and mammals that occur in your area according to the maps and information in these, or similar books. Why do you think you didn't see most of these in the area you studied.

LIVE TRAPPING-- You can live trap shrews and other small mammals by making pitfall traps. Dig a small hole in the ground and set in a small coffee can so that its top edge is even with the ground. Bait with a mixture of peanut butter, bacon fat, and oatmeal. Be sure to put cloth strips or cotton in the bottom of the can so any animal you capture can make a nest and stay warm. Checkyour traps at least every 12 hours. If traps are checked less frequently, the animals you catch may die.



HOW ABUNDANT ARE THEY? Measure a 10m x 10m area, then count the number of each species that you find in that area. Count any sign you see as 1 animal, unless it is clear that there was more than one. For example, if you found 2 sets of moose tracks--one much larger than the other, that would show that there were two moose in the area. But if you found two sets of tracks, both the same size, it could have been the same animal passing through twice. Compare your estimate of bird and mammal abundance with other groups. Could you get a better estimate of abundance using everyone's estimates? Biologists spend a lot of time and money trying to develop accurate ways of counting birds and mammals. You may want to discuss this topic with local experts and find out how they count, or census, wildlife.

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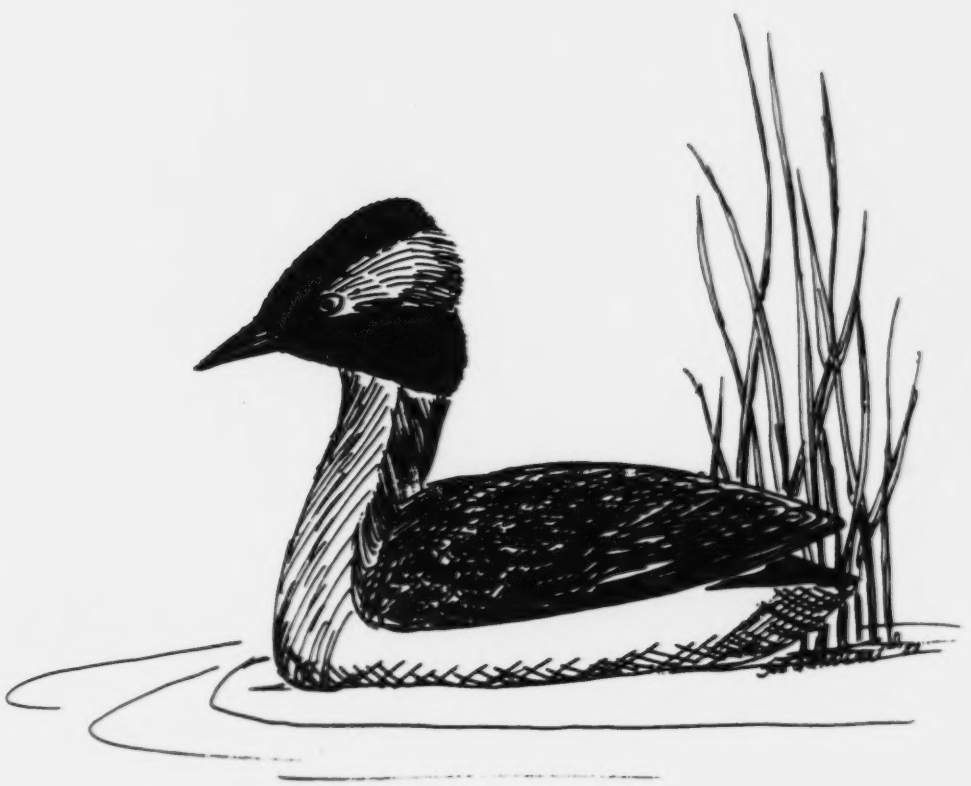
Name _____

Notes on the _____ **of** _____.
group of living things — place studied

_____. There were ____ in _____.	_____. There were ____ in _____.	_____. There were ____ in _____.
_____. There were ____ in _____.	_____. There were ____ in _____.	_____. There were ____ in _____.
_____. There were ____ in _____.	_____. There were ____ in _____.	_____. There were ____ in _____.
_____. There were ____ in _____.	_____. There were ____ in _____.	_____. There were ____ in _____.

We observed _____ **different kinds of** _____ **in our study area.**
There were a total of _____ **in the area (**_____**) we studied.**

Alaska Wildlife Week Unit 4. © 1986 ADF&G



Perspectives on the food chain.....

Hamlet: [Polonius is at supper...] Not where he eats, but where he is eaten. A certain convocation of politic worms are en'at him. Your worm is your only emperor for diet. We fat all creatures else to fat us and fat ourselves for maggots. Your fat king and your lean beggar is but variable service; two dishes, but to one table; that's the end.

William Shakespeare

Lesson 2.

JR / SR HIGH

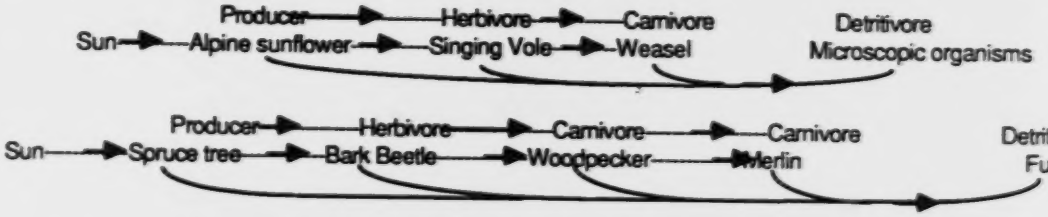
Students will be able to explain the movement of energy from the sun through the food chains and webs of an ecosystem in their area.

Background. All living things need energy to survive. Energy is used to move, sense and respond to the environment, grow, and reproduce. So where do living things get the energy they need? As mentioned in Lesson 1, energy is present in our non-living surroundings in a variety of forms-- light, heat, electricity, motion (kinetic), in chemical compounds (in the bonds between molecules of matter), and as atomic energy (the bonds within atoms of matter). Most kinds of living things can not use energy directly from the non-living surroundings--they can only get energy by eating other living things. All ecosystems include producers--living things that are able to convert energy from the non-living environment into a form that other living things can use. Plants are the main producers in forest and tundra ecosystems, while algae (includes seaweeds) are the main producers in ocean ecosystems. Both are important in wetlands. Some monerans are also producers. These producers convert the energy in sunlight into chemical energy through a process called photosynthesis. Photosynthesis is simply the change of carbon dioxide (from the air), water, and sunlight (energy) into oxygen and sugar. Sugar is a form of stored energy that living things can use. Energy and minerals are passed through ecosystems via food chains and webs. The energy in sugar is combined with various minerals to make various carbohydrates, fats, and proteins. These compounds, made up of energy and minerals, are food for other living things.

Producers are the first link in all food chains. They are called producers because they produce food for themselves and other living things. All other living things get their energy by eating other living things, (or their wastes). They are called consumers. The second link of all food chains are the consumers that eat mainly producers (plants or algae). Dall sheep, singing voles, butterflies, mosquito larvae, and other living things that eat producers are called herbivores. Consumers that eat mainly herbivores are the next food chain link. They are called carnivores, which means flesh-eaters. Phalaropes, weasels, and seals are examples of carnivores. Some food chains also include carnivores that eat other carnivores, and or omnivores, living things that eat both producers and consumers.

Detritivores, or decomposers, are organisms that get energy from eating waste materials and dead organisms. Fungi, slime molds, many insects, and many microscopic organisms (such as bacteria) are detritivores. Bald eagles, crabs, ravens, and other large animals that scavenge dead animals are also detritivores. They form links with every other food chain link, because they may eat waste and dead material from producers, herbivores, and carnivores. Detritivores are very important for reasons to be discussed in the next lesson.

Here are two examples of food chains that occur in Alaskan ecosystems. Several of the organisms in both are shown on the 1986 Alaska Wildlife Week poster. The detritivore links are often not shown in examples of food chains, but they are very important and should not be left out.

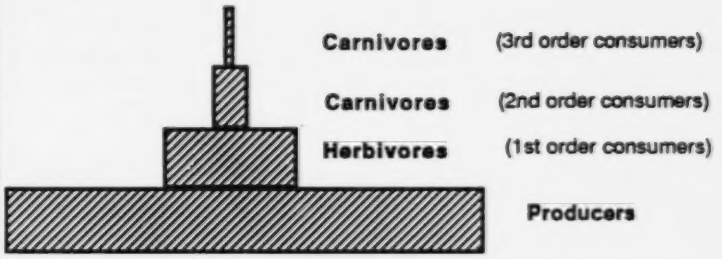


The food chain is an easy concept to understand. The exchange of energy and minerals through ecosystems is not really that simple however. Most living things eat a variety of things. Most herbivores eat a variety of plants; most carnivores eat a variety of other consumers. Some organisms eat detritivores. And some living things, called omnivores, eat producers, consumers, and detritivores. A better picture of the exchange of energy in ecosystems is a food web that shows connections between all the living things that eat each other.

Alaska Wildlife Week Unit 4. © 1985 ADF&G

A Simple Food Web

An important point to recognize is that energy is lost at every link in a food chain. All living things, including producers, use some energy to move, respond to the environment, reproduce, etc. When stored chemical energy is used, it is changed into another form--heat, motion, electricity, etc.--and thus cannot be re-used by other living things. Living things also lose a lot of energy in waste materials. In general, most living things store only about 10% of the energy in the foods they eat. Thus, in the above example, if a singing vole ate alpine sunflower seeds containing 1000 calories of energy, it would store only 100 in its tissues. Then, if a weasel ate the vole, it would get only 10 of the 100 calories stored in the vole's body. The amount of energy available limits the number of living things that can exist. As a result, carnivores are less numerous than herbivores, and food chains rarely have more than 4 links. Consumers in the 5th and 6th links of longer chains must always feed on several different kinds of living things in order to get enough energy to survive. Much of the energy lost in wastes at each link of a food chain is ultimately used by detritivores; so, actually about 80% of the energy captured by producers is ultimately used by some living thing.



This diagram generalizes the relative number and biomass of different kinds of living things that results, over time, from the loss of energy at each link in food chains. It is called the biotic pyramid. The exact shape of the pyramid varies in different ecosystems. If you look at organisms of very different sizes, the numbers of organisms at each level may not be comparable--for example, one shrub may provide food for many insects--a comparison of biomass (weight of the organisms) at each level will provide a better picture. It is also important to recognize that the relationship is best observed "over time." There will be more of each kind of organism during the season it reproduces. Also, some organisms reproduce several times per year, so thetotal biomass of organisms present at a single time may not accurately represent the biomass present over time.

Vocabulary: *carnivore, consumer, detritivore, energy, food, food chain, food web, herbivore, omnivore producer.*

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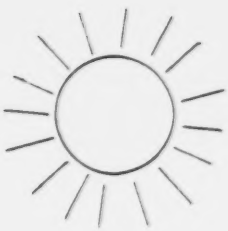
Introductory Activity.



Objectives:

1. Students will be able to explain that energy from the sun is captured by certain living things, called producers, and then passed between other living things in an ecosystem through food chains and webs.

Materials:

Alaska Wildlife Week poster, reference materials on Alaskan wildlife, index cards, yarn.

Procedure:

1. Discuss the concept of energy -- the capacity to do work. Have students give examples of energy in the non-living environment (light, heat, motion, electricity, chemical and atomic).Then discuss the needs of living things for energy (to move, respond to their environment, grow, and reproduce). Ask students where living things get their energy. They probably recognize that most get energy by eating. Write the names of the living things shown on the photo poster on the board, then have the class add the names other living things they are familiar with. Try to encourage them to come up with representatives of the 5 major groups of living things. Add the names of these to the list as they are called out. Write "eats mainly plants and algae - Herbivore", "eats mainly meat-Carnivore", and "eats mainly dead things and waste materials-Detritivore", "eats all kinds of things-Omnivore" as separate headings across the top of the remaining blackboard. Start at the top of the list of living things and help students assign each living thing to the correct category. Write the names under the correct categories. See the back of the photo poster for information on the foods of each of the pictured living things. The food chain background information on page 35 will help you place other living things in the correct categories. (Or, use reference materials.) When it comes to categorizing plants, algae, and cyanobacteria, students should recognize that they do not fit into any of the categories. So what do they do to get energy? Explain the process of photosynthesis and the ability of certain living things, called producers, to actually make their own food by getting minerals and energy (in the form of sunlight) from their non-living surroundings. Then add another category (to the area left open before) "makes its own food-Producer," and place the appropriate living things in that category. Point out the difference between these kinds of living things and all others. Draw a box around all the other categories to show that they can be grouped together as "consumers."

2. Draw in the sun to show where producers get their energy. Then draw arrows to show that herbivores get their energy and minerals from producers, carnivores get theirs from herbivores, and omnivores, and detritivores get energy and minerals from producers, herbivores, and carnivores. Review the vocabulary terms for these groups. Explain that the exchange of energy and minerals from the non-living environment to plants through other living things is called a food chain. Discuss the food chain examples given in the background for this lesson. Then help students make 2 or 3 additional examples of food chains using the living things on the list that occur in your area. Discuss the relative abundance of the various types of organisms--which are most abundant, which rare? Can students figure out why this might be? Discuss the fact that each organism is only able to store about 10% of the energy stored in the food it eats and the biotic pyramid as discussed in the background section. (continued)

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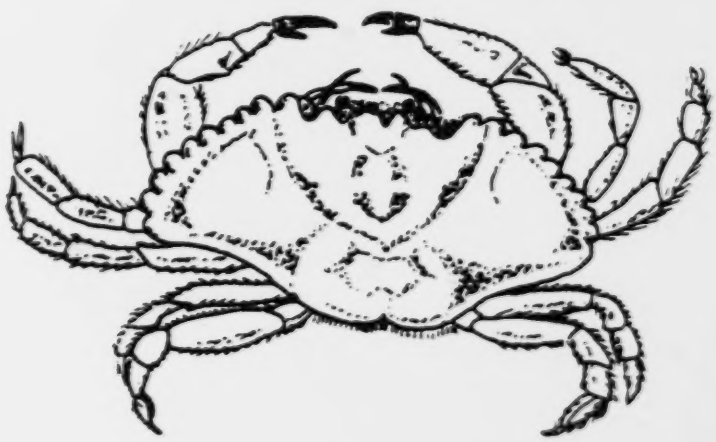
3. Divide the class into small groups and assign each one a carnivore that occurs in your area. They are to make food chains using the assigned organism as a starting point to trace backwards to the producer. They are to make cards to represent all the living things in their chains. The cards should include the name of the organism, a drawing (optional), the category it fits in (producer or consumer), and if it is a consumer, 2 things that it normally eats. They should make a card to represent each living thing that they list on the card too. For example, if their carnivore is a fox, and they list voles and shrews as the two things a fox eats, they must make a card for voles, and one for shrews; then a card for each of the 2 things these eat, and so on. Each group must also make 2 cards that represent detritivores.

Allow the groups to use any reference materials available. The food chain background information may be helpful. Don't forget the back of this and past years' Alaska Wildlife Week photo posters, and the Alaska Dept. of Fish and Game Wildlife Notebook Series. To encourage inclusion of a variety of living things, you may want to challenge your best students by giving them an invertebrate carnivore. Be sure you have books on invertebrates so they can find out what their carnivore and its prey eat, however. (If you don't have adequate resource materials, give students the information on a food web from an Alaskan Ecosystem, see page 94.)

. 4. When all the groups have completed their cards, have each group bring their cards up and pin them on the bulletin board using yarn to show the food chain connections. If two groups made cards for the same animal, the cards should be pinned on top of each other (or together), with connections to all 4 of the food animals mentioned (if each group listed different foods.) The end result of this effort should be a part of the food web of an ecosystem in your area. Explain that the hundreds of inter-locking food chains in an ecosystem are called a food web.

5. Once all the interconnections are made on the board, have students represent the living things on the cards and show the connections either by holding lengths of string between them or just by touching the other students that represent something they eat. Discuss what would happen to the food web if humans did something to get rid of one of the carnivores? One of the producers? One of the herbivores? Which would affect the most organisms? Try to find out by removing one kind of organism--that player pulls on all the strings he/she is holding (or taps all the students he/she is touching). Any living thing that feels a tug, then tugs on all the strings they are holding. All those who feel this tug, also tug their strings. Once all the tugs are felt, have everyone who felt a tug raise their hand--how many organisms were affected?



FOOD CHAIN BACKGROUND FOR TEACHERS

The following information is provided to help you create examples of food chains relevant to your specific area and students.

OCEAN

Producers--algae (phytoplankton), including seaweed

Herbivores--zooplankton (small invertebrates that float freely in the water, includes a variety of crustaceans), molluscs (including snails, limpets), sea urchins.

Carnivores-- sea stars (eat molluscs and sea urchins), some whelks, sea anemones, most fish (eat zooplankton or other fish that eat zooplankton), seals (eat fish), toothed whales (eat fish mainly), marine birds (eat fish, zooplankton, and molluscs), humans.

Omnivores-all filter feeders, (including barnacles, clams, and baleen whales) eat both phytoplankton (algae) and zooplankton.

Detritivores--most bottom-feeders including crabs, shrimp, flounder, sea cucumbers, some whelks, springtails, amphipods, and bacteria.

FOREST

Producers--plants, including trees, shrubs, herbs, ferns, and mosses; also algae (especially as part of lichens)

Herbivores--a variety of insects, including beetles, bees, butterfly larvae, craneflies, ants, wasps,; moose, deer, hares, porcupines, voles, squirrels, seed-eating birds (sparrows, finches, grouse).

Carnivores--predatory insects (aphids, wasps, spiders, millipedes), foxes, lynx, weasels, marten, hawks, owls, shrikes (eat small birds or mammals), insect-eating birds (woodpeckers, warblers, swallows, thrushes).

Omnivores--bears, jays, crows, squirrels, humans

Detritivores--fungi (mushrooms, shelf fungus, molds), bacteria, a variety of invertebrates including many insects (wasps, springtails, beetles, flies), millipedes, .

WETLANDS

Producers--algae, aquatic plants (shrubs, grasses, sedges, and mosses)

Herbivores-- some protozoans, fairy shrimp, rotifers, aquatic insect larvae (mosquitos, mayflies, stoneflies, craneflies), snails, muskrat, beaver, moose, caribou, dabbling ducks (mallards, pintails, wigeon, teal), geese, swans

Carnivores--Dragonflies and damselflies, frogs, toads, fish, mink, river otters, seals, foxes, coyotes, wolves, weasels, northern harriers, short-eared owls, insect-eating birds (shorebirds, warblers, swallows, dippers), fish-eating birds (loons, grebes, herons, kingifishers).

Omnivores--brown bears, sandhill cranes, humans.

Detritivores--bacteria, protozoans, fungi, molds, many aquatic invertebrates, (larval flies, mayflies, stoneflies, springtails), bald eagles, ravens.

TUNDRA (alpine and arctic combined)

Producers--grasses, sedges, lichens, herbs

Herbivores--lemmings, voles, caribou, Dall sheep, mountain goats, many plant-eating invertebrates (craneflies, beetles, bees, wasps, butterflies, adult flies, grasshoppers), marmots, pika, ptarmigan, seed-eating birds (sparrows, snow buntings, longspurs, redpolls)

Carnivores--predatory invertebrates (spiders, adult female mosquitos, certain flies), weasels, wolves, foxes, wolverines, snowy owls, northern harriers, golden eagles, jaegers, insect-eating birds (shorebirds, thrushes, sparrows, snow buntings, longspurs, redpolls)

Omnivores--brown bears, humans

Detritivores--bacteria, protozoans, some fungi, beetles, springtails, larval flies, arctic foxes in winter, ravens.

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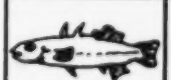
FOOD CHAIN WORKSHEET

Place a P next to the producers, an H next to the herbivores, a C next to the carnivores, a D next to the detritivores, and an O next to the omnivores. How many food chains can you find on this worksheet? On a separate piece of paper, diagram an ocean, wetland, forest, or tundra food web that shows all the organisms (pictured or listed) on this worksheet, plus at least 10 others that you can think of.

	This mushroom secretes chemicals to digest dead plants and wastes. It absorbs the digested material.
	This is a copepod. It eats diatoms.
	This is a willow. It photosynthesizes its food.
	This is an alpine avens. It photosynthesizes its food.
	This is a grebe. It eats small fish, like sticklebacks in fresh water, or sandlance in ocean water.
	This is a merlin. It eats small birds in forest or tundra areas.
	This is protist, called green algae. It photosynthesizes its food.
	This is a raven. It feeds on dead animals.
	This is a mosquito larvae. It eats protists, such as algae.
	This is a wolf. It eats moose, caribou, and sheep, especially young animals.
	Sandlance feed on zooplankton, such as copepods, amphipods, and euphausids.
	This is a 3-spine stickleback. It eats aquatic insects, like dragonfly larvae.
	Shrikes eat small birds, insects, and small mammals in tundra and forest areas.
	Loons eat mainly small fish, in fresh and saltwater. They occasionally eat large aquatic insects.

	This is a diatom, a type of protist. It photosynthesizes its food.
	This is a redpoll. It eats the seeds of willows, other shrubs, and trees.
	This is a harbor seal. It eats ocean fish, like herring.
	This is a Tanner crab. It eats dead things and waste material on the ocean floor.
	This is a Dall's sheep. It eats low-growing alpine plants, like alpine avens.
	This is a dragonfly larvae. It eats the aquatic larvae of other insects, such as mosquitos.
	Killer whales eat fish (herring and salmon especially), and sometimes seals, sealions, and other whales.
	This bacteria lives in the soil. It feeds on dead plants and animals and waste materials.
	This pika is a small mammal that lives in alpine areas and feeds on grasses and herbs.
	Red foxes eat just about anything including small mammals, small birds, bird eggs, berries, and dead animals.
	Marmots are a small mammal that live in alpine areas and feed on grasses and herbs.
	Golden eagles live in alpine areas and feed on ptarmigan, small mammals, and (rarely) Dall sheep lambs or mountain goat kids.
	Adult longspurs feed on insects and the seeds of various tundra plants.
	This amoeba eats other protists, including algae and protozoans.

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Science Math

Objectives: Students will recognize that animals do not store all the energy and minerals in the foods they eat.

Materials: small animal (gerbil, mouse, frog); food for the animal, an accurate scale.

Procedure: Ask students how much weight they think a moose would gain if it ate 50 pounds of willows? Ask students if they can think of any way to find out how much of the food eaten by an animal is actually converted into muscle, bone, fat, blood, or other parts of its body. Do they think of weighing a captive animal before and after it eats? Discuss the problems of doing this--how much food does it eat and how much is spilled? How long does it take for the animal to actually change the food into body tissues or fluids, and get rid of the wastes? How could these problems be solved?

Have students put a captive animal in a cage with a mesh bottom so that uneaten food and wastes can fall through to a collecting pan (covered daily with fresh paper). Have students weigh the animal on Days1 through 5 and make a graph of the animal's weight changes. Have them record each day the weight of the food eaten (food given it minus the food that it dropped through the mesh--this uneaten food should be separated from wastes using forceps, then weighed.) Students should also weigh the wastes--just weigh the paper before putting it in the cage, and after it is removed and uneaten food separated out. Have them sum this over the week to find the weight of all the food given the animal during the week. Have students calculate approximately what proportion of the food eaten became body tissue or fluid? What proportion of this turned up as waste? What happened to the rest of the food? (Most is lost in wastes--but be certain students recognize that much of the food eaten was given off as by products of respiration-- water and carbon dioxide. Part of the air (carbon dioxide) the animal breathed out was really broken down sugar that it ate! Much of the energy in the food (was lost as heat). Can students think of any way to accurately measure the amount of food broken down by the respiration of an animal? (Scientists are able to measure the amount of carbon dioxide given off by an animal by placing it inside a jar, then measuring the changes in the amount of oxygen and carbon dioxide in the air of the jar. This is a measure of the animal's metabolic rate. The higher an animal's metabolic rate, the more food it burns up/unit of body weight.)

ART SCIENCE MATH

Objectives: Students will demonstrate an understanding of food chains.

Materials: Various colors of construction paper, butcher paper, glue,scissors,pencils.

Procedure: Have students work in groups to think of an example of a food chain in your area then make life size 1-dimensional cut-outs of the organisms involved. Have them put their completed food chain diagrams on the walls in the hallways or in your classroom.

No man is an island, entire in itself. Every man is a piece of the continent, a part of the main; if a clod be washed away by the sea, Europe is the less, as well as if a promontory were.

John Donne

Lesson 3.

JR / SR HIGH

Students will be able to explain the cycles of water, carbon, nitrogen, and other minerals through ecosystems.

Background. Living things need energy to survive, but energy alone is not enough. All living things also need minerals--that is, naturally occurring, non-living substances with a definite chemical composition. Minerals include materials made of a single element (such as nitrogen phosphorus, oxygen, and carbon), and compounds (such as water). Different kinds of living things need different kinds and amounts of minerals for a variety of purposes. Most living things are made up of 50-95% water, along with large amounts of carbon, nitrogen, sulfer, and phosphorus. Potassium, sodium, and calcium together make up another 1%. However, many other minerals, which are present only in minute quanitites (a few parts per million) can also be critically important to the functioning of an organism. The energy that living things center their existance around obtaining is basically used to re-arrange minerals into various organic compounds--such as body tissues and fluids.

Just as all energy used by living things comes from the non-living environment--so, too do the minerals. Like energy, minerals take a variety of forms--as solid, pure or compound substances in rocks and soil; as liquids (such as water); in solution (for example, dissolved in water), and as gases in the atmosphere. Certain forms are usable to certain living things; others are unusable. For example, most living things need oxygen for respiration (the process of breaking down sugar to release its chemical energy for use). Oxygen is present as a gas (in the atmosphere and dissolved in water), and as a part of water and other compounds. Oxygen gas is theonly form usable for respiration. Birds, mammals, plants, and fungi can only use oxygen that is in the atmosphere. Fish can only use oxygen that is dissolved in water. Organisms can only use a mineral if it is present in the right form; this fact plays a major part in determining the path of minerals from the non-living environment through living things.

Mineral cycling occurs, on a geologic time scale, in the non-living environment alone. Most, though not all, minerals are present on earth mainly in solid form as rocks. Wind and water erosion alone (or aided by plants) break down the rocks into fine particles--sand, dust, and dirt. However, the erosion process of changing rocks into dirt is tremendously slow; hundreds to thousands of years are required to break a rock down. The fine grain materials that result are blown and washed around. Those minerals that can be dissolved in water are carried away by water that washes over or seeps through the dirt. Unless these minerals and dirt particles are somehow trapped, they are quickly (in comparison to the length of time it took to break them down) blown or washed to the sea or a large lake. They may remain suspended in the water for a time, but finally settle out and sink to the bottom sediments. Over millions of years, the intense pressure on the sea floor recondenses the minerals (along with detritus from the sea) into rocks. Millions of years later, these rocks may be uplifted and once more exposed to wind and water erosion. Minerals from deep in the earth may also be brought to the surface by volcanos. Minerals in the form of rocks or trapped in sea sediments are not available to living things. So, living things must trap and recycle the limited supply of usable minerals. (One study showed that the minerals in bare soil are lost 10-100 times as fast as those in the same soil covered by a forest community.)

The specific pathways of different minerals through ecosystems vary, but all minerals are cycled! They are taken from the non-living environment by certain living things (generally producers), then returned to the non-living environment by other living things (generally detritivores). The exchanges between the non-living environment and living things are repeated--over, and over, and over. Recycling of minerals is essential for the continued existance of the living things in an ecosystem. If the mineral cycles of an ecosystem are somehow interupted, the needed minerals may be leached out, eroded away, or accumulate in unusable forms. Without an adequate supply of their needed minerals, the living things can not survive, and the ecosystem deteriorates. Some examples of specific mineral cycles are given on the following pages. (You may choose to photocopy the diagrams as hand-outs or on to transparencies.)

Vocabulary: *carbon, cycle, denitrifying, minerals, nitrogen, nitrogen-fixers, photosynthesis, phosphorus, recycle, respiration, transpiration.*

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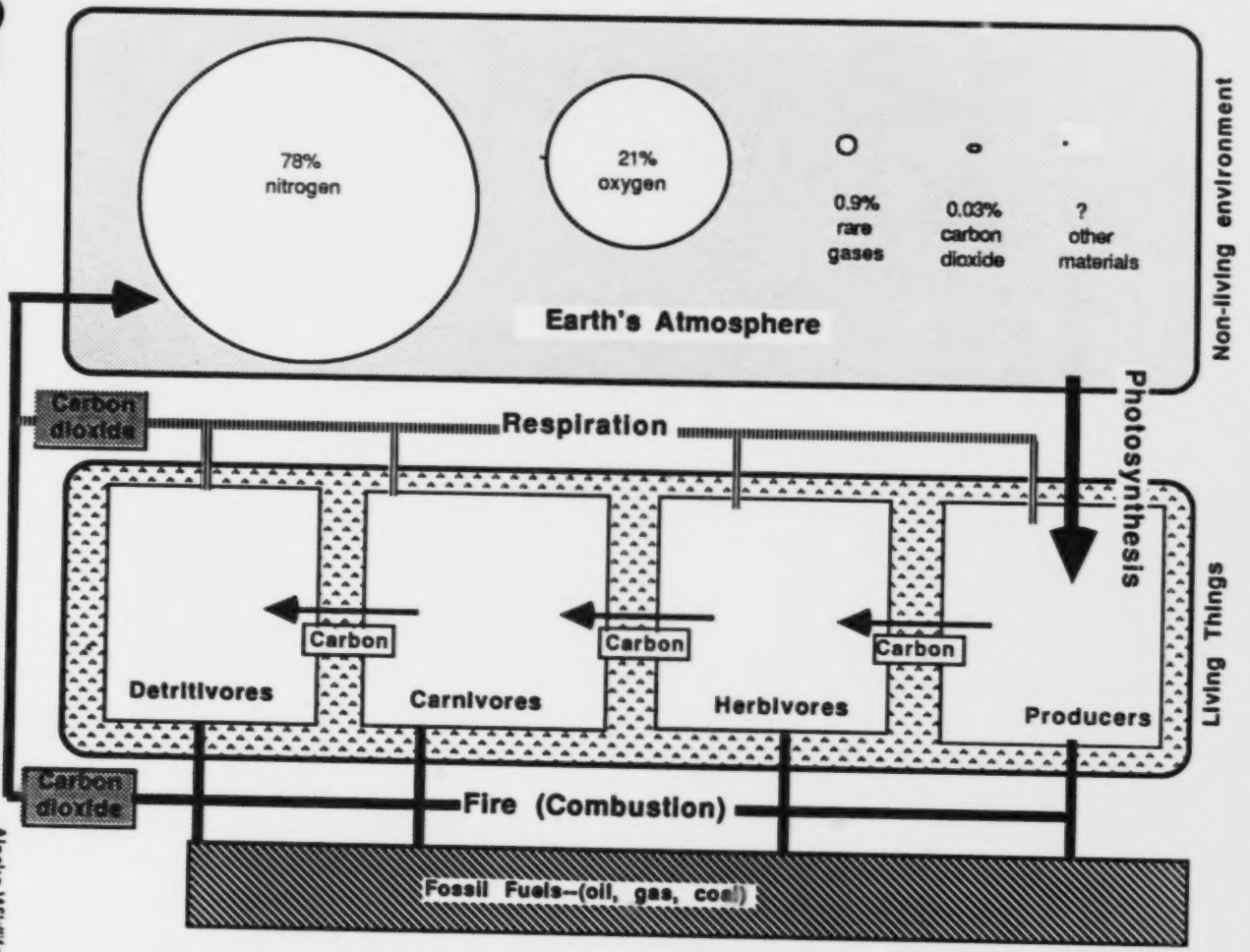
The Carbon Cycle



Respiration-- sugar is combined with oxygen to release carbon dioxide gas, water, and energy.

Photosynthesis--Carbon dioxide, water and sunlight energy are combined to make oxygen and carbon chains (or sugar).

Carbon is present in the non-living environment as the gas, carbon dioxide, and in a dissolved form in the sea. Carbon from the non-living environment is incorporated into living things by producers through photosynthesis. This carbon is then passed through food chains. Some carbon is returned to the environment at each link in the food chain by respiration.

Huge amounts of carbon are stored in fossil fuels-- the wastes and remains of the living things of past millenia (includes oil, gas, and coal). Large amounts are also trapped in sea sediments, and in wood and detritus.

This stored carbon is slowly returned to the non-living environment thorugh respiration by detritivores. It is also returned to the non-living environment very quickly by fire (combustion).

Nearly all living things are dependent on the carbon cycle. 3 billion years ago (before photosynthetic life forms evolved), the earth's atmosphere contained a large amount of carbon dioxide and no oxygen. Today, due to photosynthesis by producers, the atmosphere is about 21% oxygen and about 0.03% carbon dioxide.

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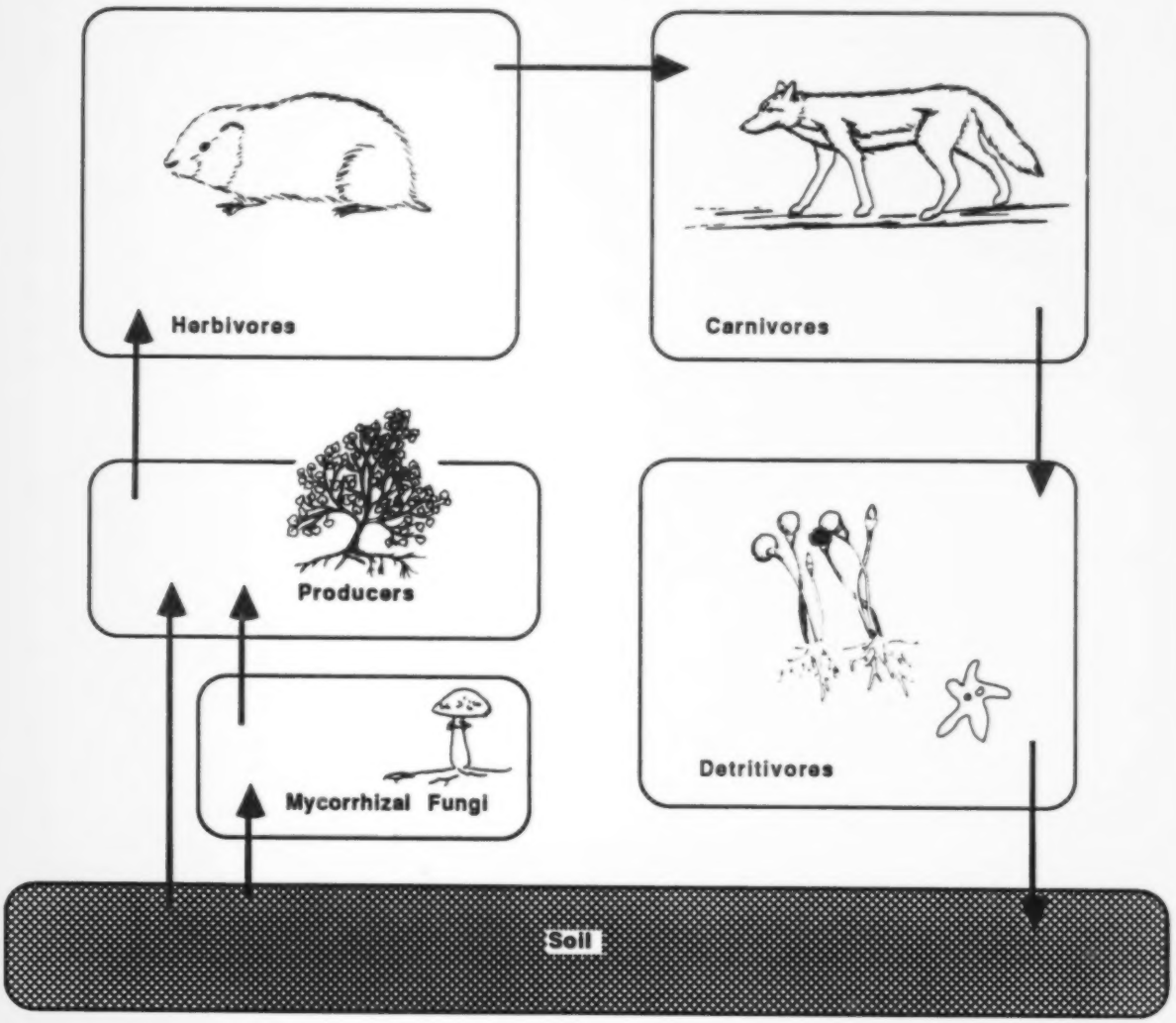
The Cycle of Minerals



Many minerals, such as phosphorus, occur in the soil. Plants can take up minerals from the soil through their roots only if the minerals are dissolved in water. Given an adequate amount of moisture, plants take up minerals from the soil and incorporate them into their tissues and fluids. Recently scientists have recognized that about 80% of all plants depend on mycorrhizal fungi, such as mushrooms to help them obtain needed minerals from the soil.Once plants have incorporated minerals into their tissues, the minerals are passed through food chains--to herbivores, carnivores, and finally, detritivores. Each organism in the food chain uses the minerals in different ways. Detritivores form a crucial link in the cycling of soil minerals, because plants can not use minerals that are locked up inorganic compounds--such as animal flesh, wood, dead leaves, etc. Ultimately, all the organic compounds must be broken down by detritivores, and the raw minerals returned to the soil. Only then can the cycle begin again with other plants taking up the minerals in the soil.

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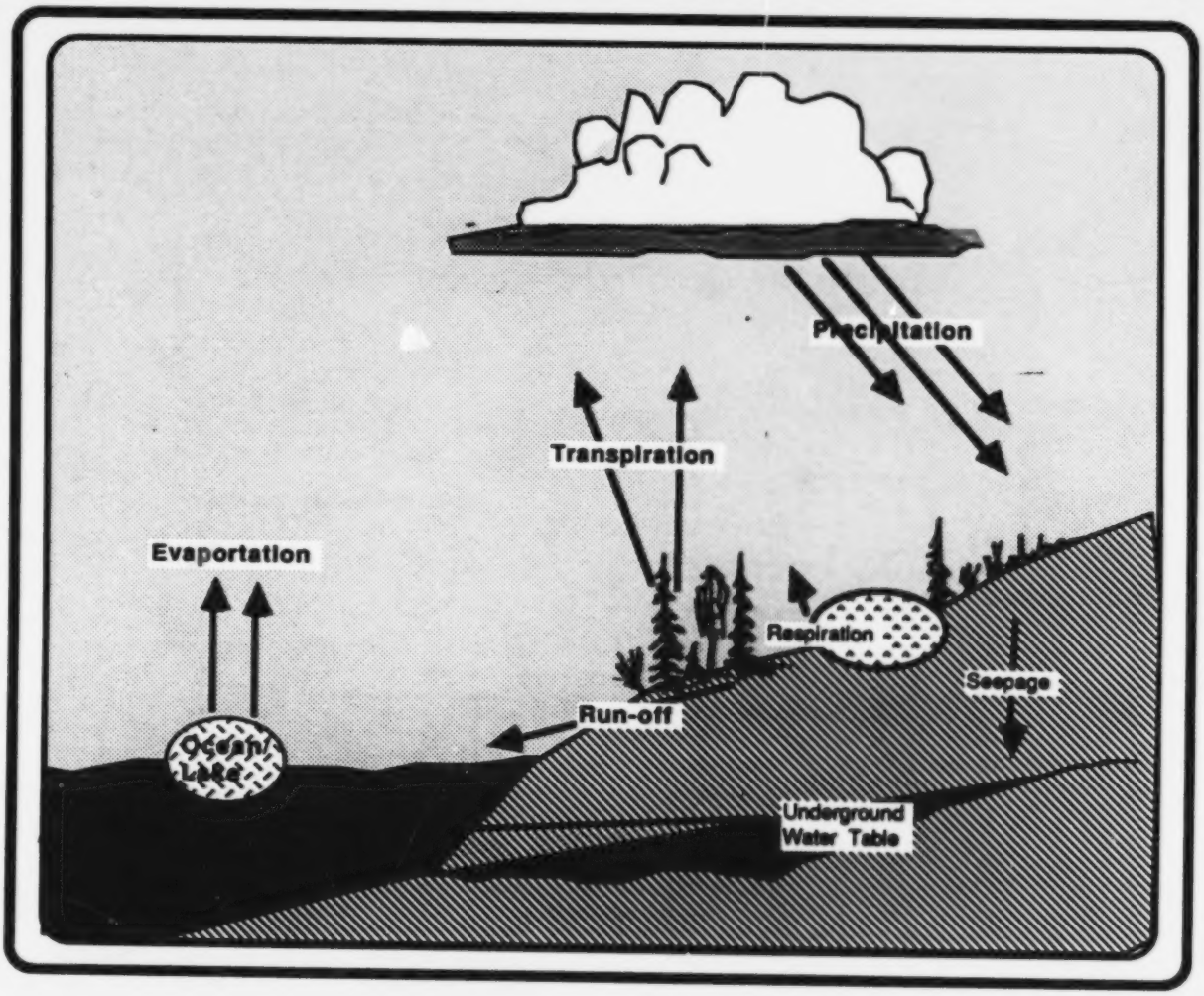
The Water Cycle



Water cycles from one form to another in the non-living environment and through living things. Water covers over 3/4 of the earth's surface; however most of this water is salty and unuseable to living things that need fresh water. Living things that need fresh water are extremely dependent on the water cycle.

Salt water is changed into water vapor through the addition of light/heat energy, or evaporation. Water vapor in the atmosphere eventually condenses into clouds and is moved over land by air currents. Water then falls to the ground as rain or snow. Once on the ground, water can either run-off into streams, lakes and eventually the ocean (where it can once more be evaporated), or it can soak into the soil. If it soaks into the soil it may seep down into underground rivers and eventually out to sea (to again be evaporated). Or, it may be taken up by plants and other organisms.

The water taken up by living things is returned to the non-living environment as a waste product of respiration. Plants also take up water for photosynthesis and to transport other minerals, such as phosphorus, that are in the soil. Plants can only take up minerals that are dissolved in water. In order to get minerals from the soil, all plants pump tremendous amounts of water up from the soil and out to their leaves. The leaves extract the needed minerals and send the excess water out into the atmosphere--a process called transpiration. Over 90% of the water taken up by most plants is returned to the atmosphere by transpiration. One tree may pump 350 gallons of water into the atmosphere every day. Thus, the amount of plant cover affects the amount of moisture in the air, and thus the amount of precipitation. An important side effect of precipitation is that it removes dust, pollen, and other particles from the atmosphere.

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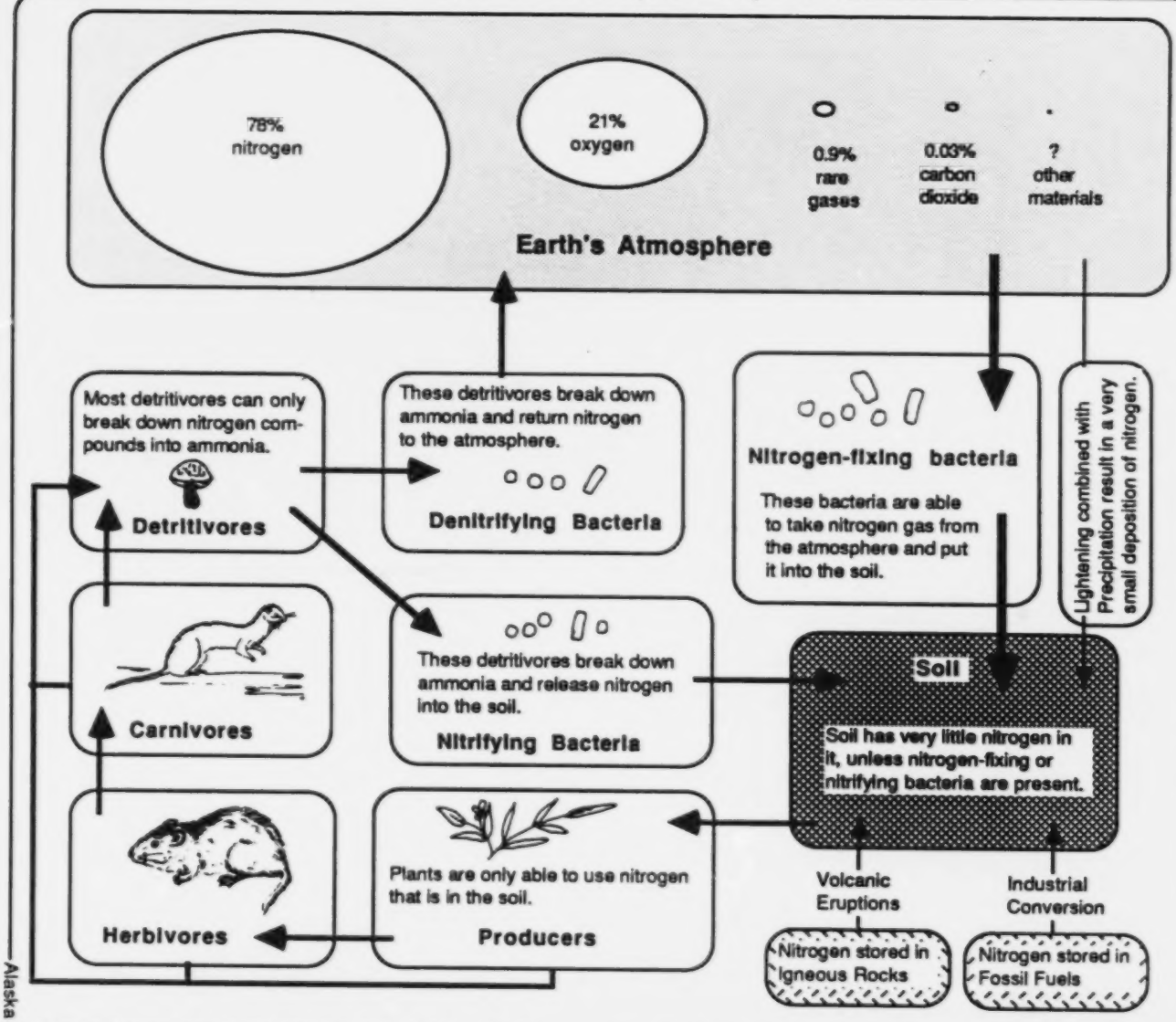
The Nitrogen Cycle


78% nitrogen
21% oxygen
0.9% rare gases
0.03% carbon dioxide
? other materials
Earth's Atmosphere
Most detritivores can only break down nitrogen compounds into ammonia.
Detritivores
These detritivores break down ammonia and return nitrogen to the atmosphere.
Denitrifying Bacteria
Nitrogen-fixing bacteria
These bacteria are able to take nitrogen gas from the atmosphere and put it into the soil.
Lightening combined with Precipitation result in a very small deposition of nitrogen.
Carnivores
These detritivores break down ammonia and release nitrogen into the soil.
Nitrifying Bacteria
Soil
Soil has very little nitrogen in it, unless nitrogen-fixing or nitrifying bacteria are present.
Herbivores
Plants are only able to use nitrogen that is in the soil.
Producers
Volcanic Eruptions
Industrial Conversion
Nitrogen stored in Igneous Rocks
Nitrogen stored in Fossil Fuels

One very important mineral, nitrogen, is cycled in a slightly different fashion. Nitrogen is a very important element that living things need to form amino acids. Most of the nitrogen on earth is in the atmosphere. Producers, the first link in most mineral cycles, are not able to extract nitrogen from the atmosphere; they can only use nitrogen that is dissolved in water in the soil. Nitrogen-fixing bacteria are the only organisms that can extract nitrogen from the atmosphere. These organisms change gaseous nitrogen into a form that dissolves in water and put it into the soil. Producers can then take it up. Nitrogen is then transfered through the food chains of an ecosystem. Once again, detritivores are a critical link, as they break down the organic materials containing nitrogen. However, most detritivores are only able to break down nitrogen wastes into ammonia--a form which plants can not use. Only nitrifying bacteria (so called because they nitrify the soil) can break down the ammonia and return nitrogen to the soil in the form needed by plants. The nitrogen is then recycled in other food chains. Denitrifying bacteria complete the cycle with the atmosphere by breaking down ammonia and returning nitrogen to the atmosphere, rather than the soil. Nitrogen-fixing, nitrifying, and denitrifying bacteria are all important in maintaining the balance of nitrogen in the atmosphere and soil.

A small amount of gaseous nitrogen in the atmosphere is transformed by lightening into a water-soluble form; this is deposited on soil by precipitation. Nitrogen is stored in igneous rocks and is added to the atmosphere and soil by volcanic eruptions. Nitrogen fixed by ancient living things remains trapped in fossil fuels. Humans are able to change the nitrogen in fossil fuels into forms that plants can take up--or fertilizers.

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Introductory Activity.

Objectives:

1. Students will be able to explain the cycles of water, carbon, nitrogen, and other minerals through ecosystems.

Materials:

Mineral cycle overhead transparencies or hand-outs (duplicated from pages 41-44), photocopies of energy and minerals cards (page 46), name tags labeled producer, herbivore, carnivore, and detritivore,1 Eco-paths Game board (pages 48-49), game markers, and a dice for every 4 students in your class.

Procedure:

1. Review the food chain concept and discuss what exactly the various organisms are exchanging--is it only energy? Discuss the definition of a mineral [any naturally occurring substance- may be composed of a single element (nitrogen) or be a compound of various elements (water, carbon dioxide)]. Discuss which minerals are important in living organisms. Have students hypothesize where living things get each of these minerals--oxygen, water, nitrogen, carbon, phosphorus, sulfer. (This question should stimulate students to wonder where and how abundant these minerals are in the non-living environment.)

Have the class do a food chain to demonstrate the need for recycling minerals. Allow students to choose what kind of organism they'd like to represent--then have all the producers wear one kind of tag, all the herbivores, another--and all the carnivores another so that each can be recognized. Select one student to represent the sun and give them the energy cards. Have the producers stand in a large circle around the sun. Scatter the minerals cards amidst the producers. Explain that producers are the only organisms that can get energy and most minerals from the non-living environment. Producer players are to pick up an energy and minerals card and paper clip them together to represent food. They can only use minerals cards that are not clipped to an energy card.

Allow the producers to begin making food while you explain the rest of the rules. You will call out turns--on each turn, players are to try to get energy and minerals via the food chain. Any player that doesn't get energy and minerals dies and is out of the game. On each turn, each herbivore, carnivore, and detritivore player must get two sandwiches. Each player checks off a square on each energy card, then (at the end of the turn) throws one sandwich to the floor as waste. Herbivores get energy/mineral sandwiches from the producers. Carnivores get theirs from herbivores. Detritivores get theirs from the"waste" sandwiches on the floor. Play the game until something goes wrong--(the producers will run out of minerals and everyone will be unable to get food). How many turns does the game last before all the players are out?

Discuss what happened in the game. Can students figure out why it doesn't happen in nature. They should guess one of two reasons--that there are so many minerals, the organisms never run out---or that the minerals are recycled. Discuss the limited availability of minerals in the needed forms--for example fresh water, oxygen, or soil minerals. Discuss the geological cycle of rock and soil formation (see background information). Emphasize that unless something prevents erosion of the fine grain materials--dirt, sand, and dust, and leaching of the minerals that dissolve in water, these quickly return to the sea and are lost (in terms of their availability to living things.)

Replay the game, except this time have the detritivores take the sandwiches apart and return minerals to the soil. (Energy cards should be placed aside as energy is not recycled). How many turns does the game last now? Could it go on indefinitely if the sun was still giving off energy? (Yes.)

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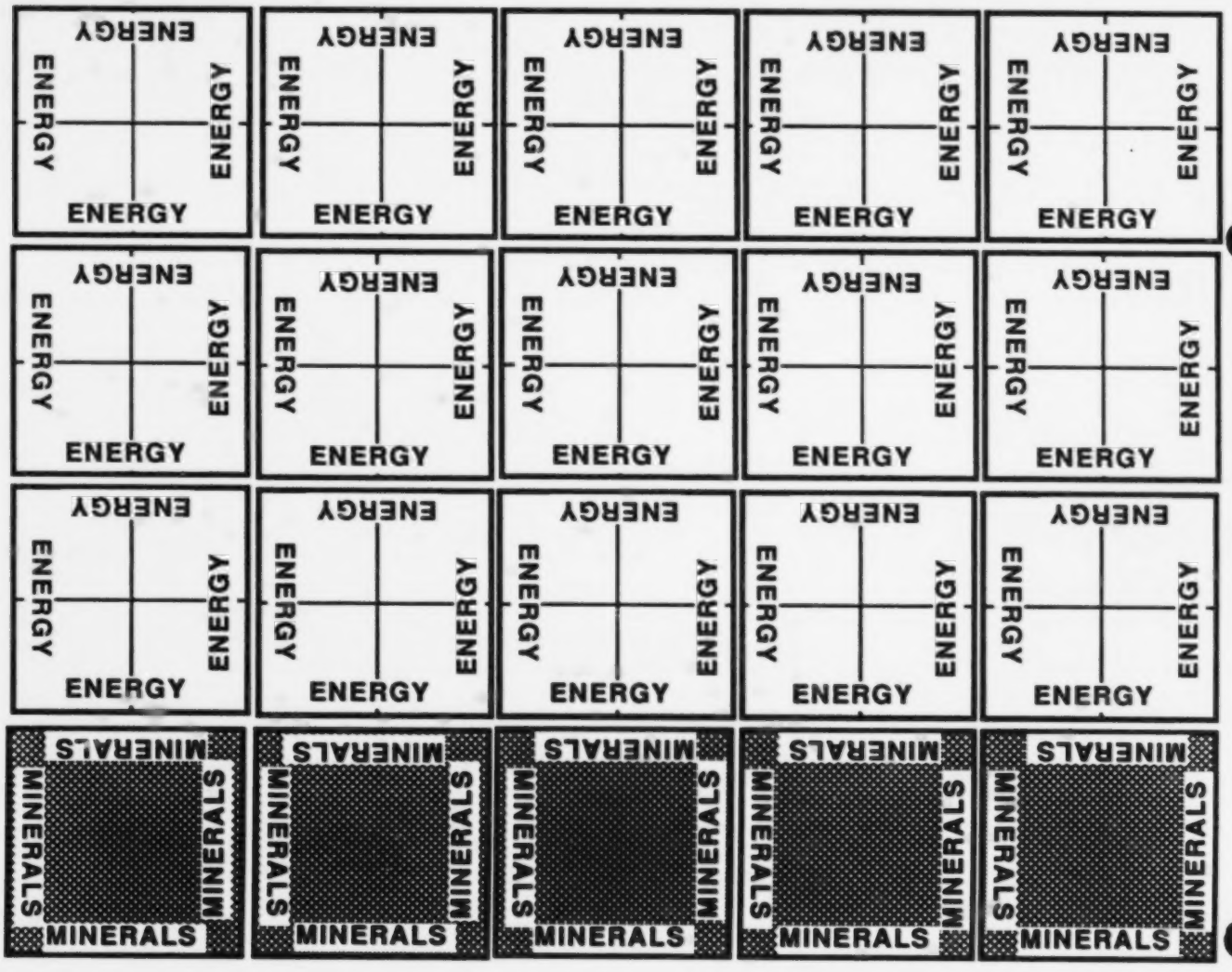
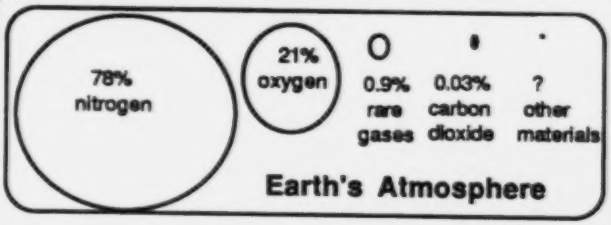
Review the minerals cycles that occur in nature using hand-outs or overhead trnsparencies of the enclosed diagrams (p. 41-44). Be sure students understand the various processes.

Have students play the Ecopaths game. The purpose of the game is to help students learn the mineral cycles through repetition. The game can be done as a station, or as a class by dividing the class into groups of 4 and giving each group a game board, dice, and 4 game markers. You can give each group a copy of the game rules (see page 50) or review the rules as a class.

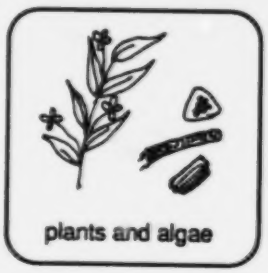
Use the Ecosystems Cycles Worksheet to find out if students learned the cycles and to challenge them to think about the importance of the various organisms that make the cycles work.

ENERGY AND MINERALS CARDS- Photocopy and cut up 6 sets of cards (for a class of 30) to make 90 energy cards and 30 minerals cards. Laminate and use washable markers so that energy cards can be re-used.

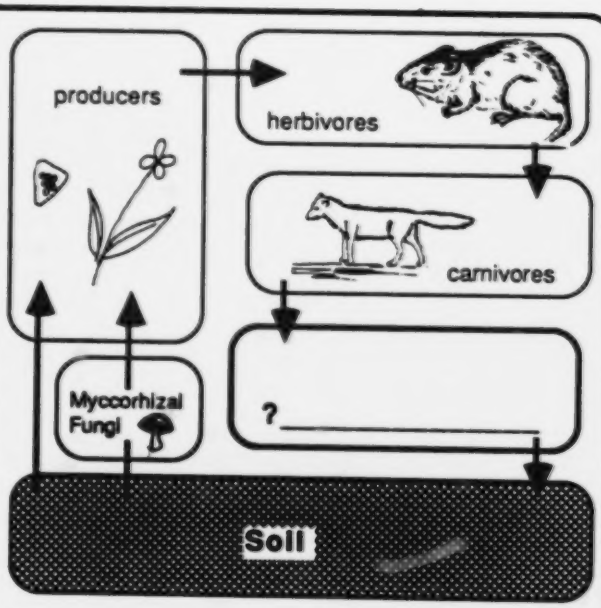




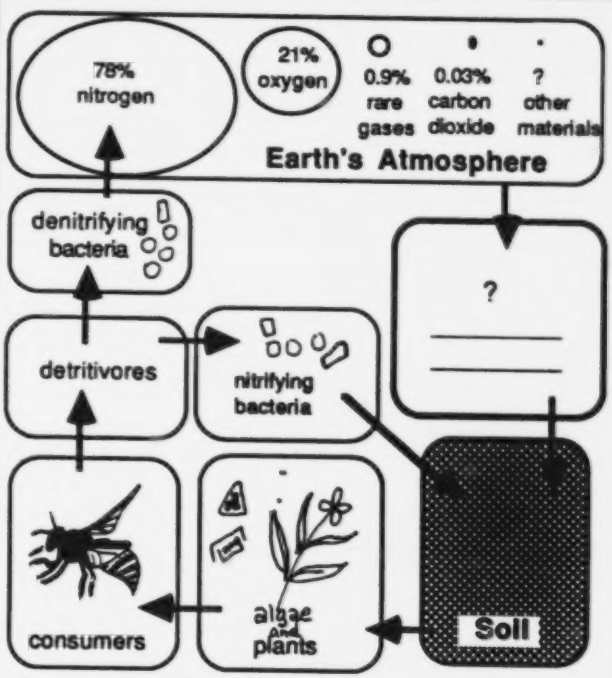
carbon dioxide | oxygen | oxygen | carbon dioxide



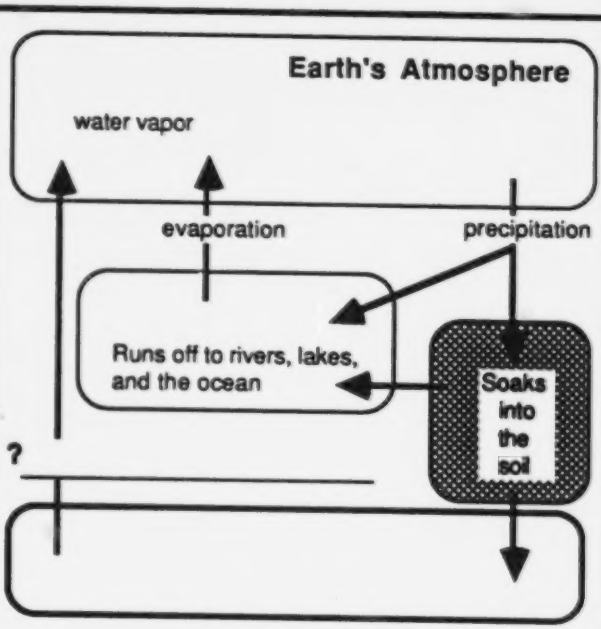
Draw in arrows between the atmosphere and these living things to show whether each takes in or gives off oxygen and carbon dioxide. What would eventually happen to the atmosphere if plants and algae stopped growing?



What kind of living things are the missing link in this diagram showing the cycle of phosphorus in an ecosystem? Name any two. What would happen if these kinds of living things disappeared?



This shows the nitrogen cycle. If it were not for the activities of the missing living things, plants would soon run out of nitrogen. What are they?



This is a diagram of the water cycle. One part of the cycle involves certain living things. Draw in an example of these living things and name the process by which water is returned to the atmosphere. What happens to the amount of water in the atmosphere if these living things are not present or are removed?

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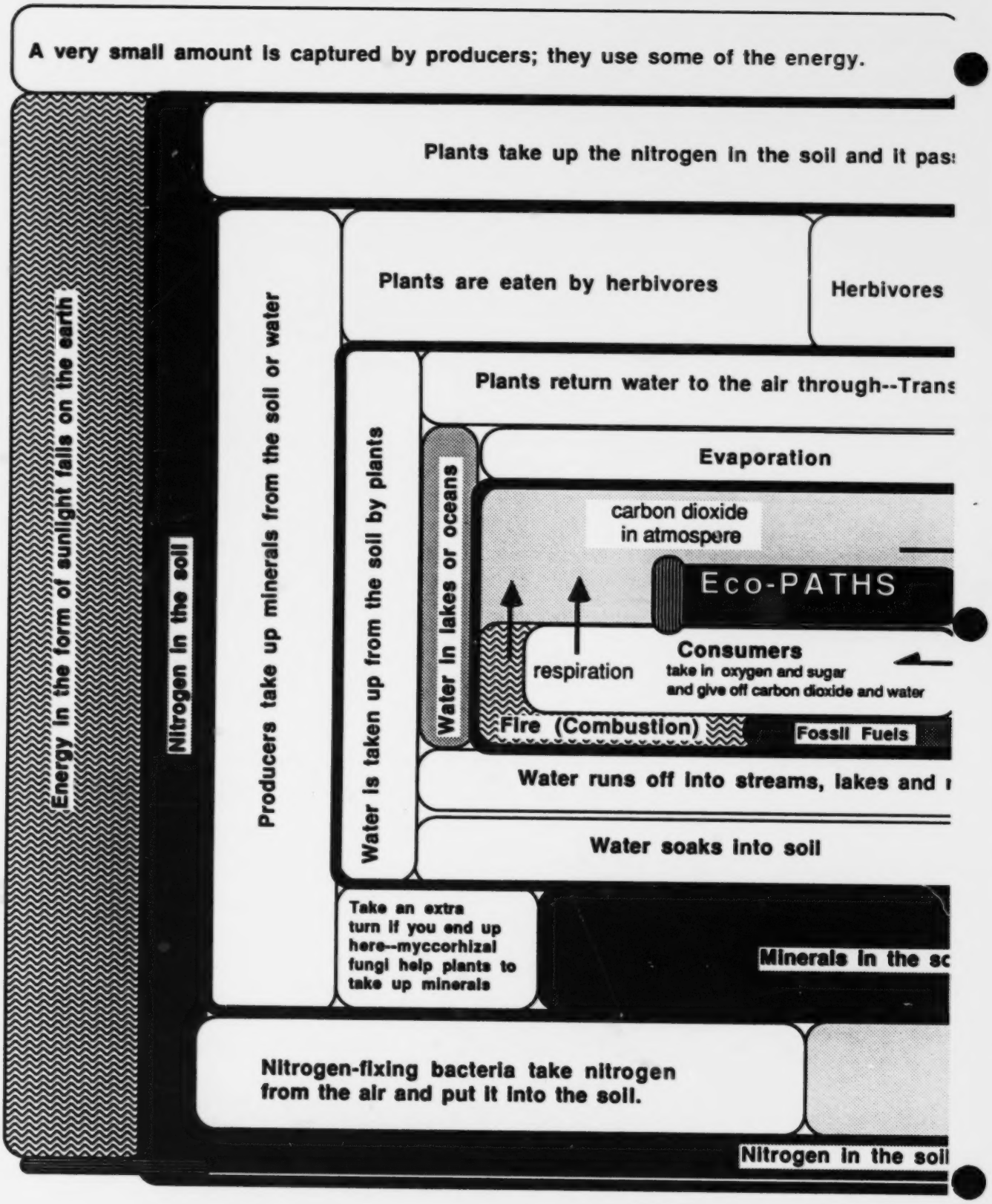
A very small amount is captured by producers; they use some of the energy.
Plants take up the nitrogen in the soil and it pas
Plants are eaten by herbivores
Herbivores
Plants return water to the air through--Trans
Evaporation
carbon dioxide in atmospere
Eco-PATHS
Consumers
take in oxygen and sugar and give off carbon dioxide and water
respiration
Fire (Combustion)
Fossil Fuels
Water runs off into streams, lakes and
Water soaks into soil
Take an extra turn if you end up here--myccorhizal fungi help plants to take up minerals
Minerals in the so
Nitrogen-fixing bacteria take nitrogen from the air and put it into the soil.
Nitrogen in the soil
Energy in the form of sunlight falls on the earth
Nitrogen in the soil
Producers take up minerals from the soil or water
Water is taken up from the soil by plants
Water in lakes or oceans

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Eco-Paths Game Rules

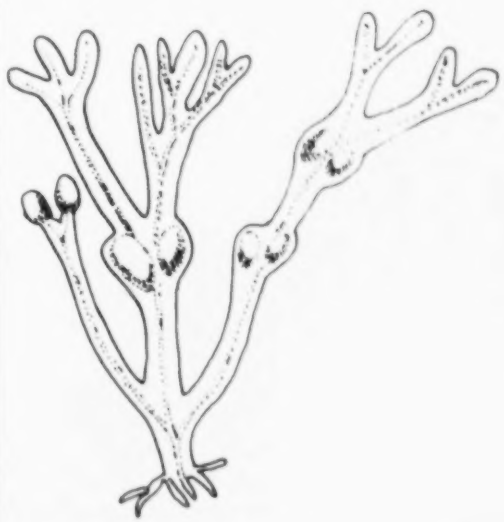
The object of the Eco-Paths game is to win the most number of points while completing all the mineral cycles, and the one-way path of energy to the end of the game. Place the game board in the center of the table with the markers in the center. Place the Ecopaths card in a place where everyone can easily reach it. The player with the lowest first toss goes first, play advances clockwise. Keep score on a separate piece of paper.

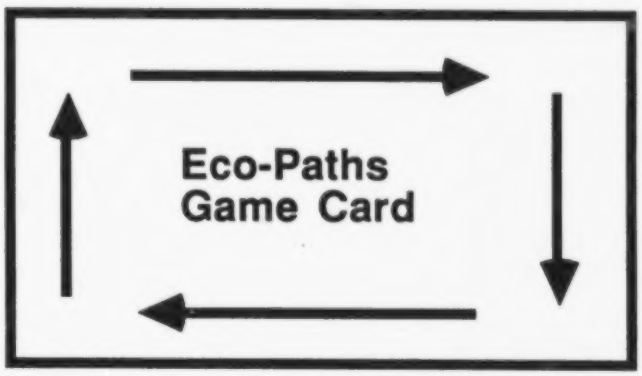
Begin by tossing the dice to find out the number of squares to move. Begin in the center square and move around the board in a clockwise direction. Each player must complete each cycle in two different ways--the inner loop, then the outer loop. Before moving on to the next cycle, each player must orally explain the cycle they have just completed.

For example on the first loop--the carbon cycle, the player would say "Carbon in the non-living env onment is in the atmosphere as carbon dioxide; producers change carbon dioxide into sugar by photosynthesis; living things turn sugar back into carbon dioxide by respiration, and thus, the carbon is returned to the non-living environment." If the explanation is correct theplayer gets 2 points, and can move to the next circle. Students may look at the board to figure out the cycle.

Then, the other players compete to get a chance to explain the alternate cycle of the mineral. The first player to place their hand on the Eco-path card explains the other route in the given mineral cycle (the combustion route of the carbon cycle in this case). If they explain it correctly, they get 1 point.

If any explanation of a cycle is given incorrectly (the other players evaluate it), the player whogave the incorrect cycle must repeat the loops of that cycle before moving to the next cycle. If the incorrect explanation is given by a player who is already in another cycle, the player must move back and repeat the cycle they explained incorrectly. If a player has not yet reached the cycle, they lose one point.





Activity Ideas for Curriculum Integration

Language Arts

Objectives: Students will demonstrate an understanding of mineral cycles by writing an essay about the journeys of a mineral molecule.

Materials: Odyssey by Aldo Leopold, an essay in the book Round River.

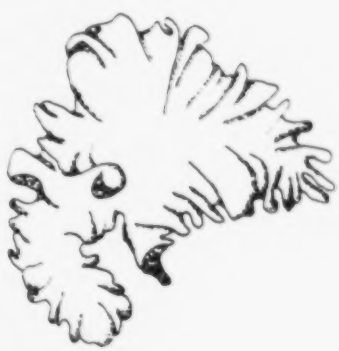
Procedure: Do the introductory lesson before doing this excercise or modify this lesson as an introduction to this section. Obtain a copy of the above essay--it should be readily available in most libraries. Read the first half of the essay aloud to the class (or have a student read it aloud). Discuss what Leopold was writing about. Was he writing about a unit of energy? (No, remeber energy is not recycled--it passes through an ecosystem only once.) Do students think he was writing about a carbon, water, phosphorus or nitrogen molecule? Assign students one of the above molecules and have them write their own imaginary story about the journeys of this molecule through the earth's ecosystems. Have them write about the journeys of a molecule that is currently in the ground of the ecosystem they are studying.

Social Studies

Objectives: Students will recognize that many minerals (materials) used by man could be recycled and thus conserved.

Procedure: Do the introductory lesson and review the importance of detritivores in breaking down the wastes in ecosystems so they can be re-used. Have students do an inventory of the waste materials produced by their household, school, or town. (This could include a trip to the dump and sewage treatment plant.) How are these wastes dealt with now? Are any recycled? Discuss the problem of dealing with waste materials. How long will the waste materials last? Will they ever decay? (Discuss which of the waste materials are made from limited resources (fresh water, oil, gas, aluminum, iron, plastic) as opposed to renewable resources (wood). Which will break down due to natural processes? Discuss whether people will run out of these materials eventually. How could things be changed so that we wouldn't run out of materials? Can we learn anything from ecosystems? Are there any "detritivores" in human communities? Do we need some?

Have students try to design a dump, or system, that would recycle all the garbage produced by their school or community. Encourage them to think of ways to recycle both the organic and inorganic wastes. Have each student (or group of students) write up a proposal for a way to recycle that includes how it would work, what would be recycled and how (also what would not be recycled), how much it would cost, and a statement of pros and cons for the system. Have students present their ideas to the class, and have the class decide on the best system considering feasibility, costs, and effectiveness. If students come up with a good idea, they may want to actually present it to the appropriate officials.



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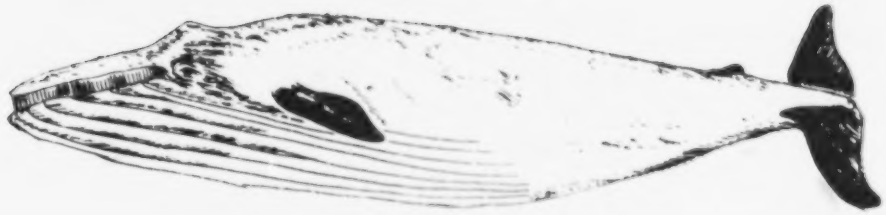


SCIENCE

Objectives: Students will understand the importance of microscopic decomposers in breaking down waste materials.

Materials: Two samples of soil from a wild area in metal containers (if possible, get samples from a forest or wetland); 2 slices of banana or other organic material, fine mesh bags.

Procedure: Sterilize one sample in by baking it at a high temperature in the oven. (This should kill most of the micro-organisms in the soil.) Be sure to label this sample--Sterilized Soil. Place a banana slice or any kind of organic material in each piece of netting and place1 of these in each of the soil samples. Cover the samples with clear plastic that has a few holes punched in it for air exchange. Set the samples in a warm, moist location and observe what happens. Which sample rots the fastest? Why?

This experiment can also be done in different locations outside. You can use other kinds of organic material--such as dead leaves--but do not choose wood as it decays very slowly. Tie the mesh bags down, so that a larger animal doesn't drag them off. Try using different sizes of mesh--nylon stocking versus an onion bag. Which sample disappears the fastest? (The sample in the large mesh bag should, because larger detritivores will have access to the material. They break down the larger particles so that smaller detritivores can gain access.)

SCIENCE

Objectives: Students will observe plant transpiration

Materials: plastic bags, rubber bands.

Procedure: Place a plastic bag around a branch of a tree or shrub with leaves, (or around the leaves of a house plant.) Put rubberbands around thebase of the bag so that air can not get in or out, but not so tightly that they cut into the plant stem. Shake another bag full of air and then close it with a rubber band. Tie the empty bag in place near the bag that is over the branch. (Or, place the empty bag and the bag with the plant in a sunny spot. If you use a potted plant be sure the plant is watered.) Leave for several hours then observe what happened. Which bag has moisture in it? Where did the moisture come from?

Math Extension: If possible leave the bag in place for several days, then measure the amount of water in the bag. (1 milliliter of water equals 1 gram.) Calculate how much water was transpired/day. Have students calculate how much water a tree with 10,000 branches might transpire in a day.

When one tugs at a single thing in nature, he finds it attached to the rest of the world.

John Muir

Lesson 4.

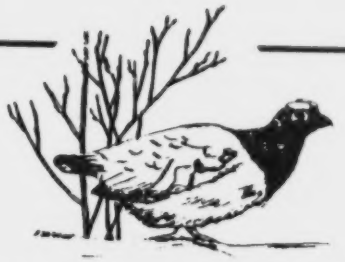
Students will be able to identify the 5 ways that living populations of living things interact: predation, competition, mutualism, commensalism, and parasitism.

Background. As mentioned in the first lesson, ecosystems are made up of the non-living environment and the living things in a particular area. As discussed, every ecosystem includes a wide variety of living things (from monerans to animals) that perform different functions (from producer to detritivore). The particular mix of organisms found in an ecosystem is called a community. The community is made up of all the populations of all the living things in the ecosystem.

The populations of living things within the community interact with and affect each other in a variety of ways. In past lessons, we looked briefly at predation--the interaction that is so important in the exchange of energy and cycling of minerals. The food chains and web of a community show the predation interactions within it. Predation is an activity that occurs between predators and prey. The populations of both players are affected through this interaction.

Predation is just one form of interaction. If we look more closely at any ecosystem, we find that, the populations of organisms in the community interact in other ways, too.

Competition is a kind of interaction that is easiest to see in retrospect. In other words, we can see the results of competition more easily than we can see this interaction occuring. Competition occurs whenever populations of two organisms are using the same resource--food, water, cover, or space--and that resource is in short or limited supply. Basically, competition is a contest. We usually just see the results of the contest-- the population of organisms that win the contest get the limited resource. The losers can not survive without the resource and so they disappear. For example, plants compete with each other for water, soil minerals, and access to sunlight. This kind of competition is easy to see because the plants can not move, and the resources within a small area are very limited. Still, when we look at the plants that occur in an area, we see the results of past competition--the winners remain, the losers are gone. To observe competition in action, we must make several observations of the competing organisms over some period of time.



Symbiosis is another kind of interaction between populations of organisms. It literally means "living together". When one kind of living thing needs another kind of living thing in order to survive, these organisms have a symbiotic relationship. In the broadest sense of the word, nearly all of the organisms within a community are symbiotic-- most depend in some way on other living things in the ecosystem. Most living things depend on producers, like plants, to make food (and oxygen), and each living thing needs the living things that it feeds on. For example, snowshoe hares need willow plants to eat, and lynx need snowshoe hares (and since snowshoe hares need willows--so do lynx). Most living things also depend on plants (in addition to those they are connected to through food chains) for cover. For, example, neither lynx nor snowshoe hares eat spruce trees, but both depend on the overhanging branches of spruce for shelter from bad weather and protection from predators (in the case of lynx, to protect their kittens from hawks and owls).

Generally, two organisms are considered symbiotic if at least one of the two can not survive without the other. Three types of symbioses are generally recognized: mutualism, commensalism, and parasitism. Mutualism is a kind of symbiosis where both of the organisms involved benefit by living together. Commensalism is a kind of symbioses in which one of the organisms involved benefits, and one is not affected. Parasitism is a kind of symbioses where one of the organisms (the parasite) benefits, while one (the host) is harmed. (Predation might really be considered a form of parasitism--or in some cases, vice-versa.) Parasites, in contrast to predators, are generally (though not always) much smaller than their hosts, and usually harm, rather than kill, their hosts.

Vocabulary: *commensalism, competition, interaction, interdependent, mutualism, parasistism, pollination, predation, spore, symbiosis*

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The following are just a few examples of symbiotic relationships between living things in Alaskan ecosystems. Many others are given in the Ecosystem Partners cards in this section.

Pollination is a good example of mutualism. In order to make seeds, many plants need to exchange pollen with other plants. Some plants rely on the wind to carry their pollen, but many kinds of plants depend on animals to perform this important task. The plants that need this help produce colorful, or sweet-smelling flowers and a sugary liquid called nectar. The flowers attract animals, such as bees, butterflies, moths, and hummingbirds, that eat nectar. While sipping the nectar, these animals get a dusting of pollen, which they then carry off to other flowers. (This is an example of mutualism.)

Some plants also need animals to carry their seeds. Some plants produce seeds with small hooks or awns that catch or grab on to animal fur--in this way they get a free ride to a new area. (This is an example of commensalism.) Other plants, like blueberry, dogwood, raspberry, and cranberry, produce edible berries. The animals that eat the berries get the energy and minerals in the berries' fleshy outer coats. The hard-coated seeds inside, however, pass through the animal's digestive tract intact and are deposited in a new area--with a bit of fertilizer. (This is an example of mutualism.). Some seeds have such a hard coating that they do not germinate readily unless passed through a herbivore digestive tract.

Many plants (some scientists estimate 80% of all species) are closely associated with certain fungi (mainly mushrooms). The fungi (the underground hyphae of mushrooms) live in or on the roots of the plants. Scientists are still trying to understand the interdependence of the plants and fungi. Apparently, the plant roots give certain foods to the fungi, and the fungi somehow help the plant roots to get certain minerals (such as phosphorus). (This is an example of mutualism.) Spruce and birch trees, blueberry, and crandberry are good examples of plants that depend on mycorrhizal fungi.

Many plants depend on nitrogen-fixing bacteria in a similar way. The bacteria live on or in the plant roots and apparently benefit from the safe, moist environment. The bacteria help the plant by taking nitrogen from the air and putting it into the soil where the plant roots can absorb it. Lupine and alder are examples of plants that have mutualistic associations with nitrogen-fixing bacteria.

Some living things are so dependent on each other that they can only live together. Lichens are a good example of this. A lichen is actually two separate living things--a fungus and an algae (or a blue-green algae now called a cyanobacterium) that live together. Although some of the fungi and some of the algae that form lichens can survive independently, many can not live without each other. In addition, by living together they can live and grow in harsh environments where neither could live alone.

Innumerable examples of parasitism can be found in Alaskan ecosystems--most involve microscopic organisms, or invertebrates. Many organisms are parasitic for only a part of their life cycle. Lamprey fish are a good example of a large parasite. The adults attach themselves to larger fish then suck the blood of their host. The host lives and feed (for itself and indirectly for the parasite) for many months after the lamprey attaches. Botfly lay their eggs on caribou; the larvae get under the animal's skin, and feed on its tissues. They then emerge, drop off, and develop into adults in the ground.

An interesting example of the tangle of symbiotic inter-relationships that can occur within a community can be found in Alaska's forests. Tree and violet-green swallows, chickadees, nuthatches, boreal and saw-whet owls, and flying squirrels nest in holes in dead trees. These animals can not dig their own nest holes. Instead, they have to find a hole that has already been made by some other living thing. These animals usually use holes that were made by woodpeckers. The woodpeckers dig new nesting and roosting holes for themselves each year; their old holes provide homes for the cavity-nesting animals that can't dig their own holes. But, woodpeckers are not able to dig holes in just any dead tree--they can only excavate a hole if the wood is partly decayed or rotted--thus the woodpeckers depend on fungi that rot and decay wood. The fungi, in turn, rely on woodpeckers and squirrels to carry their spores between dead trees. (A spore is a fungi's way of reproducing--similar to a seed.) Also, most fungi can only eat dead wood; these fungi thus rely on other organisms to kill the trees. These include insects that parasitize and kill trees, microscopic organisms that cause tree diseases and large animals, like beavers or porcupines, that kill trees. Obviously, the insects, microscopic disease-causing organisms, beaver, porcupines, fungi, woodpeckers, and cavity-nesting species all ultimately depend on the trees, as well.

Similar examples of inter-twined symbiotic relationships exist in other ecosystems, too. Likely, many still await discovery. Thus, the tangle of interdependencies depicted by food web diagrams may only hint at the complexity of interconnections between populations of organisms within an ecosystem.

Introductory Activity.

Objectives:

1. Students will learn the variety of ways that living things are interdependent.

Materials:

We all need each other Cards (see following pages), bulletin board, pins, heading labels for bulletin board: Predation--One eats the the other
Competition--They both need the same resource,
Mutualism--They both help each other;
Commensalism--One helps the other ; and Parasitism One is helped, one is hurt .

Procedure:

1. Explain that the populations of all the kinds of living things that occur in an ecosystem make up a "community" of living things. Have students try to guess why this word is used to describe all the living things in an ecosystem. Do they recognize that all the organisms within the community have certain roles (such as producer, consumer)? Do they guess that since all the living things share the same environment, that they might affect each other?

Give examples of animals that live in the same places because they are connected by a food chain. (For example, a lynx wouldn't live where there were no snowshoe hares to prey on, and a hare couldn't live where there were no willows, so we tend to find willows, snowshoe hares, and lynx together.) Review the ways that organisms that are connected through food chains need each other.

Explain that living things associate with other living things and are interdependent in other ways too. Can students think of any way that one living thing might need another--besides for eating? Put up the bulletin board headings and inform the class that they are going to play a game to learn about some of the ways that certain living things are interdependent. Pass out the cards, one per student. [(If there are more cards than students, you can use the ones most applicable to your area or play more than one round--just be sure that each time you pass out the cards that go together (marked by matching corner patterns).] Now explain that each of the living things shown on the cards interacts with one or more other living things. The object of the game is for each student to find theorganism that interacts with the living thing on their card.

Have students circulate amongst themselves to find their partners. (Some students may realize that the patterns match, so don't allow them to compare cards--just ask each other questions.) When students find an organism they interact with, they continue searching together...in some cases 3 or more organisms interact. You may want to limit the search effort to 10 minutes.

When all students have found partners, have each group explain to the rest of the class about the organisms on their cards and the interactions of these organisms. Have the group, or the class, decide which category each interaction best fits. (In the groups of 3 or more, categorize each pair of partners separately. For example, the chickadee and woodpecker have a commensal relationship. The woodpecker and fungi have a mutualistic relationship. The beetle and the tree have a parasitic relationship. Be aware that some inter-relationships may not fit the categories perfectly--students should place the relationship in the category in which they think it best fits.) When the interaction is classified, the group can write the names of the partners under the correct category on the board, and pin their cards in a row on one side of the board. (Or, make extra copies of the cards that match with more than one organism--then students can pin up sets of cards under each category) Once the bulletin board is complete, encourage all students to take time to look at it and see all the different associations.

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ECOSYSTEM INTERACTIONS

Name_____

Name the following interactions and match these names to the interactions discussed in the paragraphs below (fill in the matching letter, only). Check your answers by matching the numbers below the secret message to the letters of your answers.

In this interaction.....	one species.....	and the other species.....
v. _ _ _ _ _ _ _ _ _ _ _ (1 2 3 4 5 6 7 8 9 10 11)	struggles.....	also struggles
b. _ _ _ _ _ _ _ _ _ _ (12 13 14 15 16 17 18 19 20)	benefits.....	also benefits
g. _ _ _ _ _ _ _ _ _ (21 22 23 24 25 26 27 28 29)	benefits.....	is killed
y. _ _ _ _ _ _ _ _ _ _ (30 31 32 33 34 35 36 37 38 39)	benefits.....	is harmed
h. _ _ _ _ _ _ _ _ _ _ _ _ (40 41 42 43 44 45 46 47 48 49 50 51)	is not affected.....	benefits

52._____ Malophaga are a kind of arthropod that live on and eat the feathers of birds, such as jaegers. Due in part to the Malophaga, jaegers must molt often and grow new feathers.

53._____ This adult dragonfly lives by catching and eating adult mosquitos.

54._____ The tentacles of this anemone are green because of the green lgae that live inside its arms. The anemone's stinging tentacles protect the algae from predators; the algae produces oxygen and possibly some sugars that the anemone can use.

55._____ Kittiwake gulls locate schools of fish near the sea surface. When they feed, the flashing of their white wings and bodies is visible for a long distance. Other seabirds that see the flashing, like cormorants, quickly fly near to feed on the school of fish, too.

56._____ In Alaska, merlins usually nest in old, abandoned magpie nests.

57._____ Singing voles store up large piles of grasses and herbs to make it through the winter. They often scatter the seeds of the plants they harvest for winter food.

58._____ Adult lamprey fish attach themselves to king salmon and suck their blood for food. This weakens and may kill the salmon.

59._____ Pine grosbeaks eat the berries of high bush cranberry. They can only digest the fleshy outer coat. The hard-coated seed passes through and is deposited in a new area.

60._____ Pomarine jaegers harrass gulls until they drop any food they are carrying. The jaeger then eats the food and finds another gull to harrass.

61._____ Sundews are a kind of plant. They catch insects with the sticky hair-like structures on their leaves. These leaves then secrete enzymes that digest the insect. The leaf absorbs the digested insect.

62._____ Starlings are a kind of bird that was introduced to North America by people. They nest in holes in trees and fence posts in open areas, such as grasslands. Bluebirds also nest in holes in trees and fence posts in open areas. Few of these holes are available for birds to nest in.

63._____ Flying squirrels eat truffles, a kind of fungi. They store truffles for winter food inholes in trees and in the grouind. By doing this, they scatter the spores of the truffles throughout the forest. This helps the truffles spread to new areas.

64._____ Certain nitrogen-fixing bacteria live in the roots of alder plants. Inside the alder root, the bacteria are safe from predators and drying out.

65._____ Both red foxes and coyotes eat small mammals, birds, and bird eggs. These foods are often scarce.

_ _ _ _ _ _ _ _ _ _ _ _

ECOSYSTEM PARTNER CARDS

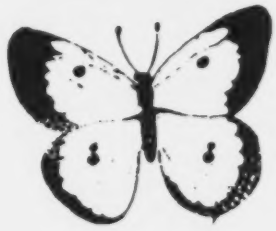
PHOTOCOPY, CUT-OUT, AND LAMINATE

Chickadees nest in small holes in dead trees, but they cannot dig their own nest hole.

Downy woodpeckers dig out small holes in trees for nesting and roosting. Other small birds can use the holes in the future.

Fireweed needs to have its pollen carried to another fireweed plant. It has nectar to feed the animal that helps it.

Butterflies eat flower nectar. They help plants by carrying pollen between flowers.



Beavers build dams on rivers in order to make big ponds. The ponds they make often drown and kill trees.

Goldeneye ducks need ponds in the forest, and a large hole in a dead tree for a nest. They can't dig their own nest holes.

This fungus makes dead wood soft, then eats the wood. but it needs a dead tree.

Flickers dig large holes in dead trees for nesting and roosting, but they can only dig in dead wood that is soft.

ECOSYSTEM PARTNER CARDS

PHOTOCOPY, CUT-OUT, AND LAMINATE

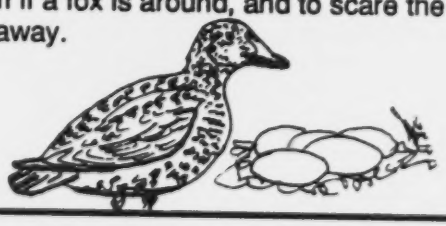
Mountain goats have long, shaggy hair. They travel from one mountain to another in the alpine tundra.

This plant needs an animal to carry its seeds to another mountain. It's seeds have long hooks that can get caught in the hair of a shaggy animal.

This algae needs a place to live in the ocean where its predators, limpets, chitons, and sea urchins, can't reach it. It will produce oxygen and food for the living thing that protects it.

This sea anemone lives attached to rocks in the sea. It allows certain algae to live inside its tentacles. It protects the algae from predators.

Common eiders nest on the ground in colonies. Foxes and jaegers sometimes get into the colonies and eat the eider's eggs. The eiders need something to warn them if a fox is around, and to scare the fox away.



Arctic terns nest in colonies. Whenever a predator, like a fox or jaeger, gets near their nesting colony, all the terns fly into the air. They start screaming and chasing the predator. Often they are able to chase it away.

This raspberry needs an animal to carry its seeds to a new area. Its seeds are inside a big red berry.

This red-backed vole likes to eat berries.

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ECOSYSTEM PARTNER CARDS

PHOTOCOPY, CUT-OUT, AND LAMINATE

This barnacle eats tiny animals and algae that live in sea water. As an adult, it needs to attach to the skin of an animal that can carry it around the sea to good feeding places.

This whale eats small animals that live in the sea. It has a lot of skin and travels hundreds of miles around the ocean to places where the water is full of tiny animals and algae.

These caterpillar larvae change into pupae. The pupae are encased in a shell and do not move or feed. If they survive, they will become adult butterflys.

caterpillar larvae

pupae

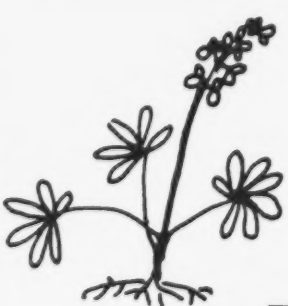
adult

This wasp needs to find a butterfly pupae in order to lay its eggs. When the wasp larvae hatch, they burrow into the pupae. The shell-like case protects them from predators and they eat the butterfly pupae.

This hermit crab needs a strong shell to protect it from predators.

When this snail dies, its body will be eaten by other living things, but its shell is made of strong material so it could make nice home for some other animal.

Lupine can only get nitrogen from the soil, but this mineral isn't in the soil where this plant is growing.



This microscopic living thing, called a bacteria, can take nitrogen from the air and put it into the soil.

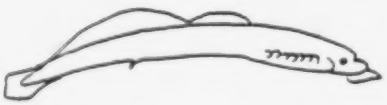
ECOSYSTEM PARTNER CARDS

PHOTOCOPY, CUT-OUT, AND LAMINATE

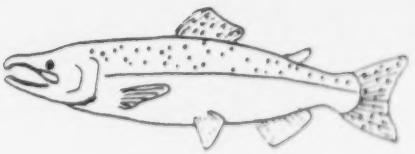
This junco lays its eggs in an open nest on the ground.

This cowbird needs to find the open nest of a small bird so it can lay its eggs. The other birds will mistake the cowbird egg for one of their own. So, they will take care of it. When the baby cowbird gets big it will kill the other chicks in the nest so it can have all the food.

Adult lamprey fish can not catch their own food. The only way they can eat is by attaching themselves to a larger fish and sucking its blood.

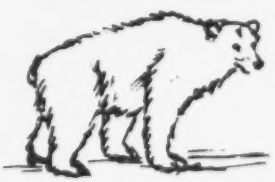


Salmon are a large fish.

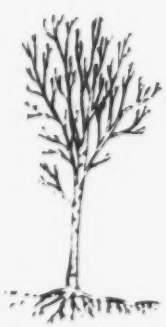


Arctic foxes can't find any small animals to eat in winter. They like to eat seal meat but they are too small to kill a seal. They need another animal to kill seals for them.

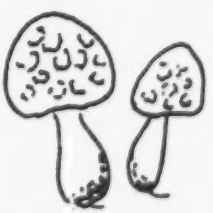
Polar bears are very large predators. They kill seals and leave a lot of scraps that other animals can eat.



This birch tree needs many minerals from the soil, but its roots can't get enough minerals. It can make food to give to the living thing that helps its roots get minerals.



The underground parts of this mushroom can help the roots of a tree get minerals from the soil.

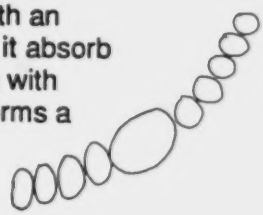


ECOSYSTEM PARTNER CARDS

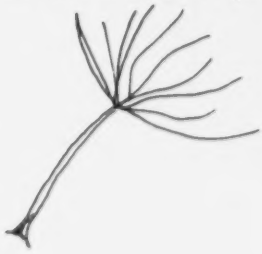
PHOTOCOPY, CUT-OUT, AND LAMINATE

This is the spore of a fungi. It can not grow unless it can live with another living thing that is capable of photosynthesis. It can absorb nutrients from its surroundings and can share these with a photosynthetic organism.

This is a cyanobacterium. It is capable of photosynthesis. It is able to grow and survive much better if it lives with an organism that can help it absorb nutrients. (HINT: Along with the other organism, it forms a lichen.)



This hydra has stinging tentacles with which it is able to capture protozoans.



This is a paramecium. It is a kind of protozoan.

This marten preys on squirrels. It also needs a warm hole to stay in during cold winter days. If possible, it would prefer not to dig its own.

This red squirrel stores hundreds of spruce cones in a big pile called a midden. It digs holes through its midden to reach cones on the inside. Air stays warmer inside these holes, because the cone pile acts like insulation.

This is a bladderwort. It is a plant and makes its own food. It also has sticky bladders that entrap insects. The bladder then secretes enzymes and digests the insects that get stuck.

This is a fly. It is a kind of insect.

ECOSYSTEM PARTNER CARDS

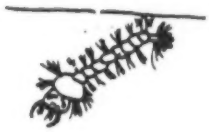
PHOTOCOPY, CUT-OUT, AND LAMINATE

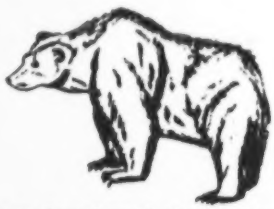
Merlins live in coniferous and mixed forests. They eat small birds that live in this habitat.

Pine grosbeaks live in coniferous forests.

Algae are microscopic organisms that live in water.

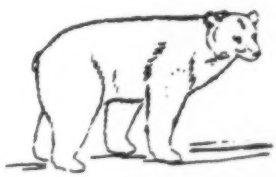
Mosquito larvae live in the water and feed on microscopic organisms in the water.



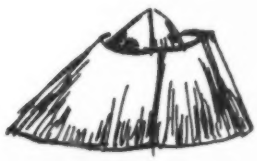


Brown bears feed mainly on the roots of plants and berries. They also eat ground squirrels, fish, and moose and caribou calves, and dead things.

Black bears feed mainly on the roots of plants, and berries. They also feed on fish, and they will eat small animals, and any kind of dead animals.



In order to feed and survive, blue mussels must attach themselves to rocks along a wave-washed shore.



In order to feed and survive, barnacles must attach themselves to rocks along a wave-washed shore.

SCIENCE / LANGUAGE ARTS

Objectives: Students will practice memory and listening skills and become more familiar with the inter-relationships of living things.

Materials: Ecosystem Interactions Cards

Procedure: This activity is for a station or group of 3-5 students. It is similar to the card game "Go Fish." The dealer shuffles the interactions cards together, and deals a hand of 5 cards to each student. The object of the game is to find sets of cards that show living things that interact. When a student gets a set of two or more that go together, they discard the set in front of them. At the end of the game the student with the highest number of discarded cards (not sets) wins. On each turn, a player asks one other player for a specific card by saying: I have a.... Do you have something it interacts with? If the player that is asked has a card of an interacting organism, they must tell what the organism is and what it does, then turn the card over to the other player. That player then makes a set, names the kind of interaction, and if correct, discards the set to his/her pile. If the player successfully discards, they get to ask for some other card. If a player draws the correct card, but names the interaction incorrectly--another player may get the set and the extra turn by challenging, and correctly identifying the interaction. When a player is unsuccessful, they draw a card and the turn passes to the next player. Students should try to remember who has what cards in order to find the ones needed for a set. There are some sets of 3 or more. A player with 2 cards in such a set should discard them on their turn by laying them down and naming the interaction. If another player gets a third card that goes with a set of 2 that has been discarded, they can discard their matching card to their own pile (on their turn) by specifying and naming the interaction. If they do not discard a matching card, and another student realizes the match, that student can ask for the card and discard it to their own pile. Game ends when all the cards are discarded.

SCIENCE

Objectives: Students will observe some of the effects of herbivores on plant populations.

Materials: An outdoor site, 1/2 inch wire mesh or fencing, rebar (reinforcing rod) stakes, and wire.

Procedure: Before doing this activity, you may want to check with local biologists to find out if they have any exclosures already set up for large animals (such as moose). If so, students can compare the vegetation inside and outside those exclosures. Your class may then want to set up additional exclosures for small mammals.

Otherwise, this activity is really a long term undertaking. If begun this year,it will provide an excellant demonstration for future classes of the effects grazing animals have on plants. The idea is to set up an exclosure that keeps small herbivores out of an area so that you can see what changes in vegetation occur as a result of their activities. The results will not be visible for one or more seasons, however, so this year's students will have to look back on their own to see what happens. (If you will have the same students 3 years down the road and can have them re-examine the exclosures--great!) About the shortest time in which you might see some results in is after one summer, or one full winter.)

You can set up the exclosure(s) and control plots in a fully vegetated area. Or, clear off several control and exclosure areas, then see what returns to the two sites. You need not enclose an area any larger than 0.5 m square, but you may want to erect more than one exclosure. To keep small mammals and birds out, bury the mesh sides 10 cm or so into the ground.Be sure the sides are secure by overlapping the wire mesh and wiring it every 2-4 cm. Cover the top of the exclosure with mesh also. You may want to have the top 1 m or so off the ground, if vegetation in the area includes shrubs.

Be sure to take pictures of the sites in year 0, and record a list of the plants found inside and their relative abundances.

SOCIAL STUDIES

Objectives: Students will recognize that humans are interdependent with other living things, too.

Procedure: Review briefly that all living things have an effect on other living things that live in the same ecosystem. Have students give some examples. All the living things in an ecosystem are sometimes called a community--the same word that is used to describea group of people that live in the same area. Ask students whether or not humans do things that are important for other people that live in the same community? Have students name as many jobs done by people as they can think of (baker, teacher, garbage collector, house builder, etc.). List these in column 1 on the blackboard. Label column 2, Non-living things and column 3, Living things. Then, go through each job listed and discuss whether the person doing the job needs things from the non-living environment (if so, list these in column 2) or other living things (if so, list in column 3), in order to do their job. When finished with this, ask students whether they think their human community could survive without the surrounding ecosystem. They should recognize that most of the jobs people do require things from the non-living environment or other living things--i.e. ecosystems.

Discuss this idea further. Are there any jobs done by living things in the ecosystem, that people can't do? [Make oxygen and food!; change waste materials back into minerals (we can do this with some materials by burning them); make soil, wood, rubber, and certain medicines]. Students should recognize that humans are dependent on other living things for food, oxygen, mineral recycling, and materials for building. Are humans part of the ecosystem?

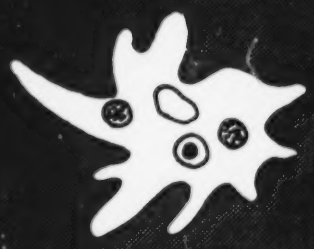
Ask each indivdual student to come up with one example each of competition, parasitism, predation, mutualism, and commensalism between humans and other humans, and between humans and some other kind of living thing. They should describe the interaction, and why they think it is a good example of the specific type of interaction.

SCIENCE MATH

Objectives: Students will be able to predict how a change in the population of one species might affect populations of the species it interacts with.

Procedure: Students will practice math and graphing skills in order to see changes in population size. Explain that in order to better understand how populations of organisms interact, the class is going to play some games to model various kinds of interactions.

After using these models to simplify the concepts, have the class discuss the difficulties that might arise in trying to accurately predict the actual effects of predators on their prey, parasites on hosts, or competitors on each other. (A wide variety of factors complicate understanding and prediction, including differing ratios of interacting organisms; the importance of habitat or other factors in limiting the two interacting populations, differences in the reproductive rates of the interacting organisms (you can explore the effects of this a little by varying the suggested reproductive rates in the models); and the fact that each interaction does not occur separately and they may have combined effects. (Every population of organisms may be affected by predators, parasites, competitors, and possibly commensal or mutalistic interactions silmultaneously. See the last game for a little about this.) Because of the wide variety of complicating factors, scientists have found a variety of situations. For example, sometimes predators control prey populations. But, sometimes they do not. Scientists have observed both cases even in studies of the same predator and prey populations in the same location at different times!



PREDATION

Game 1: Predator / Prey Model

Materials: 30 cards labeled food, water, and cover, 20 name tags each for predators and prey.

Begin with 1 predator, 5 prey, and plenty of food, water, and predator cover cards. Also make 20 or so prey cover spots (tape X's, baseball bases, or large pieces of cardboard) Have one student make a graph on the board that shows the number of predators versus number of prey. Assume1 student represents 100 organisms (to make sure students understand that they are modeling population responses). Predators must catch 2 prey (but they can catch more) and get a water and cover card to survive. Prey must get a water and food card, then run to a cover spot to survive. If they are caught by a predator before getting their cards and reaching cover, they do not survive. Surviving predators will reproduce themselves once, surviving prey will reproduce 3 of themselves. Add a new player with the appropriate name tag for each new predator or prey produced. Play the game for 2-3 turns to see what happens to the two populations. Then, change the starting ratio of predators to prey--5 predators, 10 prey-- what happens? Try changing the reproductive rates of the predators and prey (in separate simulations). Have students explain how they think predator and prey populations interact. (Simplistically--If there is abundant prey and few predators, the predator population will grow. If there are few prey, and many predators, the prey population will decline--eventually followed by a decline in the predator population.)

PREDATOR--PREY AND CAMOFLAUGE

Game 2: Predators and prey coloration model

Materials: two colors of paper; choose the colors depending on the environment you are doing this activity in. It can be done in the classroom or outdoors. Choose one color that blends in well with the major background, and one that stands out against most available backgrounds. Cut the paper up into small (about 2x2 in) square pieces.

Procedure: Choose 2 students to be the predators, and 2 students to graph the populations. Have the predators leave the room for a few minutes. Divide the class in half. Give half of them the squares of one color, and half, the squares of the other color. Explain that some species of animals have individuals with different coloration patterns--for example foxes, many insects (such as butterflies and moths), and some rodents. (Some arctic ground squirrels are nearly black, while others are brown). These are called color morphs. Most species show a gradation of colors from light to dark. Explain that the pieces of paper students have represent a population of one kind of animal--the square--which occurs in two color morphs. Each student is to put their square out, in plain view, somewhere in the room. The graphers show the starting populations of each morph on the graph.

Then,call the predators back in. Explain to them that they have 1 minute to find and catch their prey--the wily "square". Show them an example of a square (size and shape) cut out of white paper. Then let them go, and time them. Then they leave the room again. (They can take their prey with them, or return it to the teacher, depending on your supply of squares).

Conduct a census of the surviving squares, and graph this number. Each surviving square can then reproduce. (For example, if 10 yellow squares and 5 black squares survived, add 10 more yellow and 5 more black squares to the game.) Students set these out and call the predators back. Again they have one minute. Repeat this several times--be sure to census the survivors (and add the appropriate squares to represent reproduction of the survivors) after each turn. What happens? (The least conspicuous color morph should soon far out number the conspicuous color morph.) You may want to discuss the effects of a change in the environment--or change the environment and repeat the game . (What if the custodians painted the room black? Or, in the wilds, the trees were coated with soot from burning of coal, or dust from a road).
Questions for further thought: Do students think that in every population with two color morphs, one color morph will always eventually disappear? What might keep both color morphs in the population? (Repeated changes in the environment--that alternately favored the two morphs. There could be some advantage in the coloration unrelated to predation. Perhaps one color morph is better able to attract mates, able to catch more of their own prey, or other.).

Be sure to pick up all paper scraps if you play this game outdoors! (Inside too, if you want to be polite to the custodian.)

COMPETITION

Game 3--Competition Model

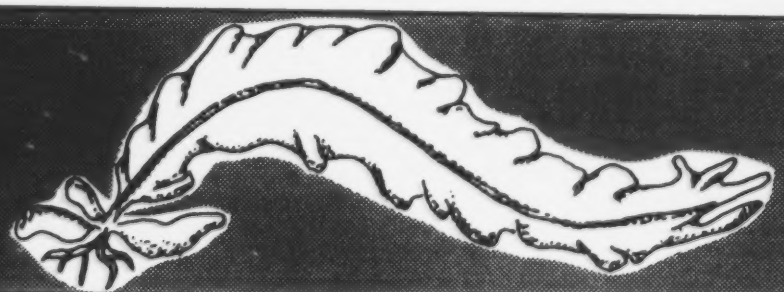
Ask students to hypothesize what happens when populations of two kinds of organisms are competing for the same, limited resource. Then assign 5 students to represent competitor 1; and 5 students to represent competitor 2. Put out plenty of water and cover cards, but only 9 food cards--put some of the cards up high and some down on the floor under tables. When you say go, both groups try to get food, water, and cover cards--but all players must hop on one foot.

Only those players that get all three cards survive. Survivors reproduce themselves once (add new players and return used cards to the game). Play several rounds; have one student graph the population size of the two groups using the number alive at the end of each turn. (Again, assume1 student represents 100 organisms to ensure students recognize this as a population phenomenon.) What happens? (One group may displace the other, if one group has better players--or both groups may just go up and down in number.)

Ask students to predict what would happen if one species was a better competitor than the other? Try the following simulation to test their hypothesis. Introduce a new group that can walk on both legs. (Or assume one of the organisms in group 1 gains an adaptation through a mutation, or by learning a new way of acquiring food). These new players can teach, or genetically pass ontheir method of catching food to their offspring. Play several more rounds. What happens? (This population will soon get all the resources, the other(s) will lose.)

Next ask students to predict what would happen if both species began specializing to use just part of the resource. To show specialization, have species 1 begin moving around by crawling and get only food on the floor, the other species should continue to move around by hopping, but take only the food that is high up. What happens? (Both populations should survive and continue.)

Have students try to locate examples of possible competition between organisms in your area (two animals that use similar foods, or similar nesting sites). Can students find any evidence that competition is reduced by specialization (small differences in resource use.)



COMMENSALISM

Game 3. Commensalism
How do commensal populations affect each other?

Materials: name tags for species 1 and species 2, water, cover, and 2 kinds of food cards.

Procedure: Assign 2 students to represent species1 (the benefitors), and 2 to represent species 2, the unaffected species. Toss out plenty of water cards and plenty of 2 kinds of food cards--one kind for each species. Explain that species 2 in this example makes the cover needed by species 1 (eg--as in the woodpecker --cavity nester examples, or in the example of a beaver and an animal that needs a pond). Species 2 players do this by taking 2 cover cards from a central place and putting one of these on the floor. Species 1 can only pick up a cover card from the floor. Surviving players of either species will reproduce themselves once.

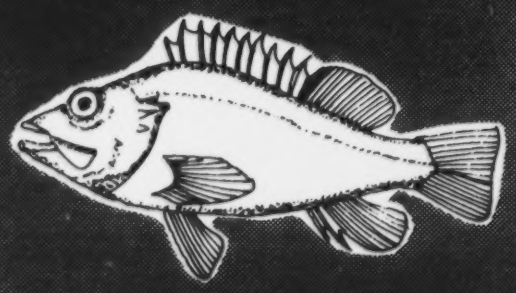
First, what happens if there are many species 1 (the benefitors) and few species 2 (the benefactors)? Try a ratio of 5 to 1. (Species 1 will be limited by the availability of cover--which is limited by the number of species 2.) What if there are many species 2 and few species 1? (Species 1 will not be limited by cover.) Is the population of species 2 ever affected by the number of species 1? (No.)

MUTUALISM

Game 4. How do mutualistic populations affect each other.

Materials--plenty of food, water, and cover cards, name tags for species 1 and species 2.

Procedure: In this game both species can get water, but only one species can pick up food cards, and only one species can pick up cover cards. The only organisms that survive and reproduce at the end of a round will be those that have food, water and cover. Let students figure out how to be a survivor and reproduce. Limit the time on the turns, or add a predator population to take out those that don't get food, water, and cover. Do any students figure out how to survive--by cooperating with an organism of the other species? Try changing the ratio of the mutualistic species. What if there are few species 1 and many species 2? What if there are many species 2 and few species 1? (Students should be able to predict that the number of survivors is limited by the species that is least abundant.)



PARASITISM

Game 5. Parasite Model

Materials: Food, water, and cover cards; parasite and host cards; competitor and/or predator name tags.

Procedure: Ask students to hypothesize how parasite populations might affect populations of their prey. Test their hypotheses by putting out 10 food, water, and cover cards. Have one student graph the populations of parasite and host. Parasites need only grab on to a host in order to survive--they should make the host drag them around. (More than one parasite can attack the same host). The hosts must get food, water, and cover cards to survive. Parasites that attach to a host that survives, survive and reproduce 1 of themselves. Surviving hosts reproduce one of themselves. Try the simulation with 2 different ratios of parasite host--2 parasites, 10 hosts, then 10 parasites and 2 hosts. On each turn, note how many parasite infested hosts die and how many survive--is their any difference?

Next, discuss with students that competition, predation, and parasitism all may interact to influence a population. Have players represent predators, prey, parasites on the prey, and/or competitors with the prey. What players tend to survive now? (Those that aren't infested with parasites should have a better chance.)

Whenever we attempt to amend the scheme of Providence, and to interfere with the government of the world, we had need be very circumspect, lest we do more harm than good. In New England they once thought blackbirds useless, and mischievious to the corn. They made efforts to destroy them. The consequence was, the blackbirds were diminished; but a kind of worm, which devoured their grass, and which the blackbirds used to feedon, increased prodigiously; then, finding their loss in grass much greater than their saving in corn, they wished again for their blackbirds.

Benjamin Franklin

Lesson 5.

JR / SR HIGH

Students will be able to identify the ecosystem components that are important for conservation of specific wildlife, and for humans.

Background. The many inter-relationships between living things, and between living things and the non-living environment make ecosystems both resilient and fragile. Any change in the non-living environment, or in a population of any living thing, is likely to cause many other changes within an ecosystem. Changes in the non-living environment can affect all living things, because all use air, water, and minerals, and are affected by temperature, humidity, and light. A change in a population of one living thing will affect the populations of all the other living things it interacts with--through food chains and webs, or other kinds of interactions. The resulting changes in these populations, may in turn, affect the populations of all of the different living things these interact with. This chain reaction of changes means that a single change--in the non-living environment or in the population of a single kind of living thing--can indirectly affect many, or all, the living things in that ecosystem.

Ecosystems can and do tolerate and absorb changes in the non-living environment (such as weather and climatic changes, earthquakes, floods, etc.). Ecosystems can also tolerate and absorb changes in the numbers and kinds of living things present; extinction of certain species and invasion by others are natural, and over geologic time, constant occurences. All ecosystems are in a state of continual change.

However, too many or severe changes in either the non-living environment, or the populations of living things can cause an ecosystem to fall apart. While such a collapse may make the area uninhabitable for its present residents, species with adaptions suitable for the changed environment may colonize and become established. After a long period of time, a new ecosystem may thus appear--with a whole different community of living things interconnected by different food webs and symbioses. In the long run, the collapse of an ecosystem may only be undesirable from the standpoint of survival of the particular organisms that were adapted for and dependent on the original ecosystem.

However, from a practical standpoint, we humans must be concerned the chain reaction of changes that can occur within ecosystems. We must be if we are interested in conservation of any specific kind of wildlife, and if we are interested in human welfare. For the survival of every species (including the human species) depends not only on protection of its populations, but also on protection of the entire ecosystem in which it lives.

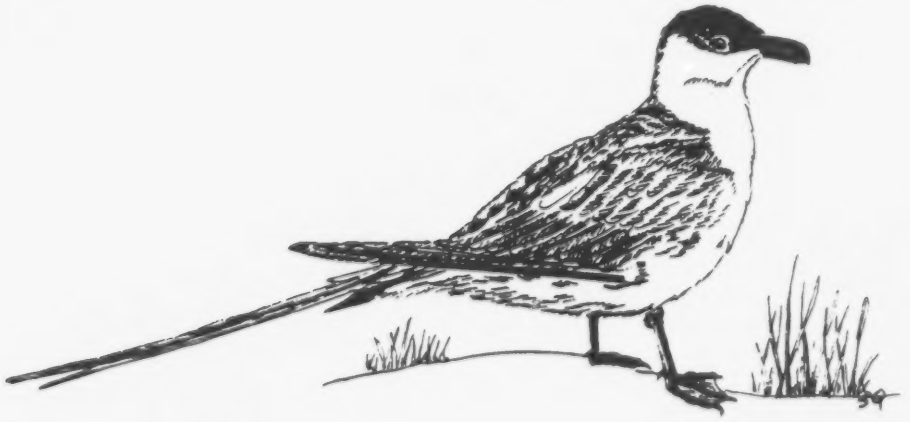
For example, in order to protect salmon, we must not only protect them, but also the non-living environment they use, and all the organisms they depend on. The non-living environment the salmon need includes the stream water and gravel beds where the salmon eggs are laid and hatched, and the sea where the salmon grow to adult size. It also includes the stream's tributaries, the river the salmon use to migrate to and from the sea, and the rain water that forms the stream and river. The living things needed include those that produce the oxygen salmon need to breathe (phytoplankton and aquatic plants). It includes the shrubs and trees that grow beside the stream, providing cover and the shade that moderates stream temperatures. Also included are the living things the salmon eat--from the stoneflies and other aquatic insects they eat as larvae, to the herring and sand lance they eat as adults. It also includes the organisms the prey feed on--(dead plant materials (largely from the streamside trees and shrubs) and zooplankton, respectively). Finally, it also includes the organisms those depend on. (The plants depend on detritivores to recycle minerals, and may depend on animal pollinators and/or seed carriers, and on fungi or bacteria to help them obtain certain minerals; the zooplankton need phytoplankton.) Thus, if we intend to conserve salmon populations, we must also conserve all the parts of the ecosystem in which they live.

Vocabulary: *consequences, denitrifying, detritivore, nitrogen-fixiing, phytoplankton, zooplankton*

Alaska Wildlife Week Unit 4. © 1985 ADF&G

People are often thought of as somehow separate from the surrounding wilds, but like all other living things, humans are a part of the earth's ecosystems. We need water, minerals, and air from the non-living environment. We need plants and algae to produce oxygen and maintain the composition of our atmosphere. We also need these producers to make food for animals and ourselves. We also depend on plants to reduce soil erosion, moderate our climates, and maintain the water cycle. We depend upon nitrogen-fixing bacteria and denitrifying bacteria to maintain the nitrogen cycle. We need bacteria and fungi to break down waste materials and recycle the raw materials needed by plants. (About 80% of the biomass created by photosynthesis is ultimately broken down by detritivores--without them, all that biomass (leaf litter, dead animals, fecal wastes, etc. would just accumulate!). Humans also need certain chemicals produced by bacteria, fungi, and other organisms as medicines. And we need many of the materials made by plants (and animals) for clothing, shelter, and machinery (for example, wood, paper, cotton, silk, wool, rubber, certain oils). We also depend on predators, parasites, and disease-causing micro-organisms to keep populations of other organisms in check. (A study in the Pacific Northwest indicated that the use of pesticides to control insect pests would cost $ /acre just to achieve the level of natural population control by ants and birds.)

Clearly, we humans depend upon the non-living environment and other living things. We are a part of the earth's ecosystems. Thus, changes in the earth's ecosystems affect us as well as all other living things. Our worldwide population of over 4 billion humans is causing changes in most ecosystems of the world. Nearly every human activity affects ecosystems. While some changes may be desirable, it is very important to recognize that every activity has potential consequences. Even an activity that seems only to affect insects, or fungi, the upper atmosphere, or ground water supplies can have far-reaching consequences. We must be very careful to ensure that the effects on the earth's ecosystems of any given human activity (or the cumulative effects of several activities) will be effects that we want--and that we can, very literally, live with.



Introductory Activity.

Objectives:

Students will learn that in order to protect any kind of wildlife, we must protect all the other living things they depend upon.

Materials:

Large open area with carpeting; reference materials on wildlife (may be able to do without).

Procedure:

Have the class nominate animals for the title "Our Favorite Animal," then take a vote to choose one. Assign 2 or 3 students to represent the favorite animal. Have the class list the parts of the non-living environment that their favorite animal needs--assign one student to represent each of the parts.

Have the class name the living things their favorite animal eats (write these on the board)--assign students to represent each of these. Have students list 2 things eaten by each of these animals (again write on the board), and assign students to represent those. Have students list 2 or 3 living things that make the oxygen needed by their favorite animal; write these on the board and assign one student to represent each one. Determine if there are other living things that help any of the living things so far listed (don't forget pollinators, seed carriers, etc.). List these on the board, and assign students to represent them.

Now , choose one of the least popular living things listed (or have the class vote on their least favorite animal--from those listed on the board.) Does the class think it would matter if people did something that caused that unpopular living thing to die out? (For example, if humans spread a poison that killed that organism, or destroyed its habitat.)

Explain that they are going to play a game to find out. Have students stand in a circle on the carpeted area or tumbling mats. They represent parts of an ecosystem--but they are not yet an ecosystem, because they are all standing alone. In order to represent an ecosystem, they all must become interdependent. Ask them to place their hands on the shoulders of the person next to them. Then everyone should take a step toward the center of the circle and take the hand of the person just beyond the person next to them. (Hands should be grasped behind the back of the person next to each student.) Then have everyone lean back, knees bent slightly, and walk their feet in toward the center. Then ask the student representing the unpopular living thing to let go. What happens? Was their favorite animal affected? Have the class discuss why we would need to protect all the living things listed on the board in order to protect their favorite animal.

Have each student use the Favorite Living Thing Worksheet (p. 82) to repeat this exercise for another animal. Then have students role play a public hearing. Individual students must convince the public, or an appointed judge or board that an unpopular living thing is important and should be conserved. (See the Social Studies activity (in the Curriculum Integration section for this lesson) for a fun extension of this idea.) Have students make bumper stickers or posters declaring the importance of their unsung wildlife heros.

Help save the peregrine falcon....
Protect Cranefiles!

Alaska Wildlife Week Unit 4. © 1995 ADF&G

My Favorite Living Thing

JR / SR HIGH

Name_____

_____

(fill in the name of your favorite living thing)

This living thing depends upon:

_____ _____ _____ _____

(its non-living surroundings)

_____ _____ _____ _____

(the living things that make the oxygen it breathes)

_____ _____ _____ _____

(the living things that help the producers)

_____ _____ _____ _____

(the living things that my favorite living thing eats)

_____ _____ _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

(the living things that each of these eat)

_____ _____ _____ _____

(any living things needed by any of the above living things)

In order to protect my favorite living thing, we are going to have to protect the _ _ _ _ _ _ _ _ _ _ to which it belongs.

Alaska Wildlife Week Unit 4. © 1985 ADF&G

Activity Ideas for Curriculum Integration

JR / SR HIGH

SOCIAL STUDIES

Objectives: Students will be able to explain the importance of less well-known or unpopular organisms, and will be able to describe the U.S. political process. (Accomplished by holding a school-wide election for most important living thing.)

Materials: art supplies for making bumper stickers, posters, buttons, costumes, etc.; reference materials for student research would be useful but are not imperative.

Procedure: (Before doing this activity, do the introductory lesson , so that students have a clear understanding of the ecosystem importance of less well recognized living things. It would also be helpful for students to do the Social Studies/Science activity--Ecology Puzzlers (next column) sometime before or early on during the nomination process.)

Have students organize and hold a school-wide election for the Most Important Living Thing. You may want to assign students in your class to try to get a less well known or unpopular organism elected, or this same end might be accomplished by setting up the appropriate political parties. You could have 5 "political" parties perhaps--the Monerans, Protists, Fungi, Plants, and Animals--or the Nitrogen-Fixers, the Producers, the Herbivores, the Detrtivores, and the Carnivores. The first step is to hold party caucuses where preliminary nominations are made. At this step you may want to just involve your classes, but the final election should include the whole school. (You may want to have students dress in costumes and play the roles of the nominees.) The caucuses would be followed by campaigns for the party nominations, and culminate in party conventions. Assistant Important Living Thing running mates for the party candidates should be selected at the conventions. Then hold the full-blown party campaigns, complete with speeches, posters, radio and TV ads, bumper stickers, buttons, and debates by the candidates. Students representing the candidates could dress up like the nominated organisms and visit other classrooms to give speeches on why they should be elected. (Other organism "heavyweights" (or symbiotic species) could dress up and proclaim their support for various candidates, too) Then finally, hold the election--complete with an electoral college if you wish!

FOLLOW-UP with a discussion of the difficulties of communicating complicated issues, the effectiveness of campaign slogans, and the effects of appearance, charisma, name recognition, etc. on election results.

SOCIAL STUDIES SCIENCE

Objectives: Students will be able to use their understanding of ecology to determine the possible effects of an environmental change.

Materials: Ecology Puzzlers--see pages 87-92.

Procedure: Give each individual student, or small groups of students, an Ecology Puzzler. They should read the facts and try to solve the puzzle at the bottom of the page. Each student or group should write down their answer to the puzzle. You may have each student or group do all the puzzles, or have each group do just one or two. Have the individuals or groups present their puzzle and conclusions. Have the class comment on and discuss the conclusions, then read the respective Ecology Puzzler section: What ecologists have puzzled out.

After reviewing and discussing a puzzle that involves human activities (2-6), have students discuss how they might individually be affected by the ecosystem change. How might humans in general be affected? Then, have students discuss what they themselves do that might contribute to each specific ecological problem. (For example, placer mining affects stream ecosystems-- is gold used in any material used by students (jewlery, tooth fillings)? Pesticide pollution is a problem-- do students eat foods from agricultural crops that are raised with the use of pesticides? The increasing amount of carbon dioxide in the atmosphere is a problem-- do students (or their families) burn fossil fuels?Plastic particle pollution is a problem--do students use plastics?) Have students discuss how and whether, they individually, or their community collectively, could help solve or reduce these ecological problems.

As a final step, have students (individually, or in groups) select a local human activity and evaluate its effects on local ecosystems. Students must decide what facts they need, then locate these in resource materials, by asking experts, and or by making observations and collecting data. Have each student or group write up a report that includes:

1) an assessment of the effects of the activity on the ecosystem based on their knowledge of ecology;

2) an evaluation of the desirability of these effects (from the perspective of humans and wildlife) and

3) possible methods of reducing or preventing the undesirable effects.

SCIENCE SOCIAL STUDIES

Objectives: Students will be able to explain the importance of ecosystem functioning for maintenance of life on earth.

Procedure: Have individuals or groups of students design a self-enclosed ecosystem to support human life in space or on Mars. They must consider in their design that they will have limited resources which will have to be used frugally and be recycled. The ecosystem they design should provide all the necessary life maintaining services--production of ingestible energy and minerals, recycling of nutrients, and cleansing the environment of toxic materials. They should try to make the design as realistic as possible. They should explain what living things and non-living things they will need to start and keep the ecosystem functioning. They should also consider where they will get these start-up materials.

Have students present their designs to the class, and have the class evaluate whether or not they think each ecosystem design would function properly. Can they recognize flaws in the designs of other students?

Student designs can be evaluated based on whether or not they included a way for sunlight to enter their system to provide energy, whether they included producers to make food and oxygen, detritivores to break down human and producer wastes, and nitrogen fixers and nitrifying bacteria to maintain a balance of atmospheric nitrogen. Did they describe the ways that water and air would be cleaned, and how these and minerals would be recycled. Did students give any thought to use of plants versus algae as the producers. Did they consider the need for pollination of plants? Did any students think of ways to get needed minerals from space, asteroids, or other planets, rather than from the earth?

An interesting follow-up of this for students would be to read the accounts of the Apollo 13 moon mission, which almost ended in disaster due to "ecosystem" problems. See The New York Times April 16, and April 25, 1970, and Life Magazine, May 1, 1970. Students may also want to write NASA to find out where they are in development of self-enclosed ecosystems for manned interplanetary flights.

Topics for further discussion include: 1) the importance of ecosystem functioning to all life (including human)on earth; 2) the metaphor "the spaceship Earth" and 3) whether or not colonization of space is a viable solution to the ecological problems on earth created by human over-population.

SCIENCE MATH ART

Objectives: Students will learn that human activities affect ecosystems by comparing areas with and without human disturbance.

Materials: Access to two outdoor sites-- one undisturbed site, and one affected by human activities, (a playground, parking lot, or lawn is adequate, but you may also choose a site that is affected by an activity such as logging, mining, or agriculture). Be sure to select areas that otherwise have similar non-living environments (i.e. both dry, or both wet, and on slopes of the same general aspect.) 11 x 17 drawing paper, pencils, crayons, clipboards or other drawing surface.

Procedure: It is very important that students actually visit the outdoors and see, observe, question, and analyze. Seeing is believing! This activity can be done at different levels of intensity. The most intense level would be to repeat the Science activity: Ecosystem Investigations (see pages 19-26) at the disturbed site, and compare the results to those obtained at a wild site. Alternatively, the class, or students on an individual homework basis, should visit the two selected sites and follow the instructions in the adjacent column--Looking for the Ecosystems.

When students have completed the two drawings, (with the class or individually) have them open up their folded papers to display their two pictures side by side. Discuss the differences, if any, in the color of the air, water, and soil at the two sites. Use the numbers they recorded to make bar graphs of the numbers of animals, producers, and fungi found at each site. Have students compare what the bar graphs and their drawings show. Have students try to construct food chains and webs for each of the sites and estimate the relative number of producers, herbivores, carnivores (2nd and 3rd order carnivores), omnivores, and detritivores at each site. Which has the most variety of each group. Does any group of consumers make up a greater proportion of the living things in the disturbed site? (Omnivores may because they are more able to adapt to changes in the food web.) What differences are there in the two ecosystems? Why do they exist? Did human activities affect the ecosystem? If so, what specific activities caused the differences?

Looking for the Ecosystems

Fold a large sheet of drawing paper (11 x17) in half to form two 81/2 x 11 sheets; label one half--A Wild Ecosystem--and the other side, The Ecosystem after Humans Changed It. Visit the undisturbed site first.

1. Walk around to look for animal sign and explore first. Then sit down and observe the area right where you are sitting.

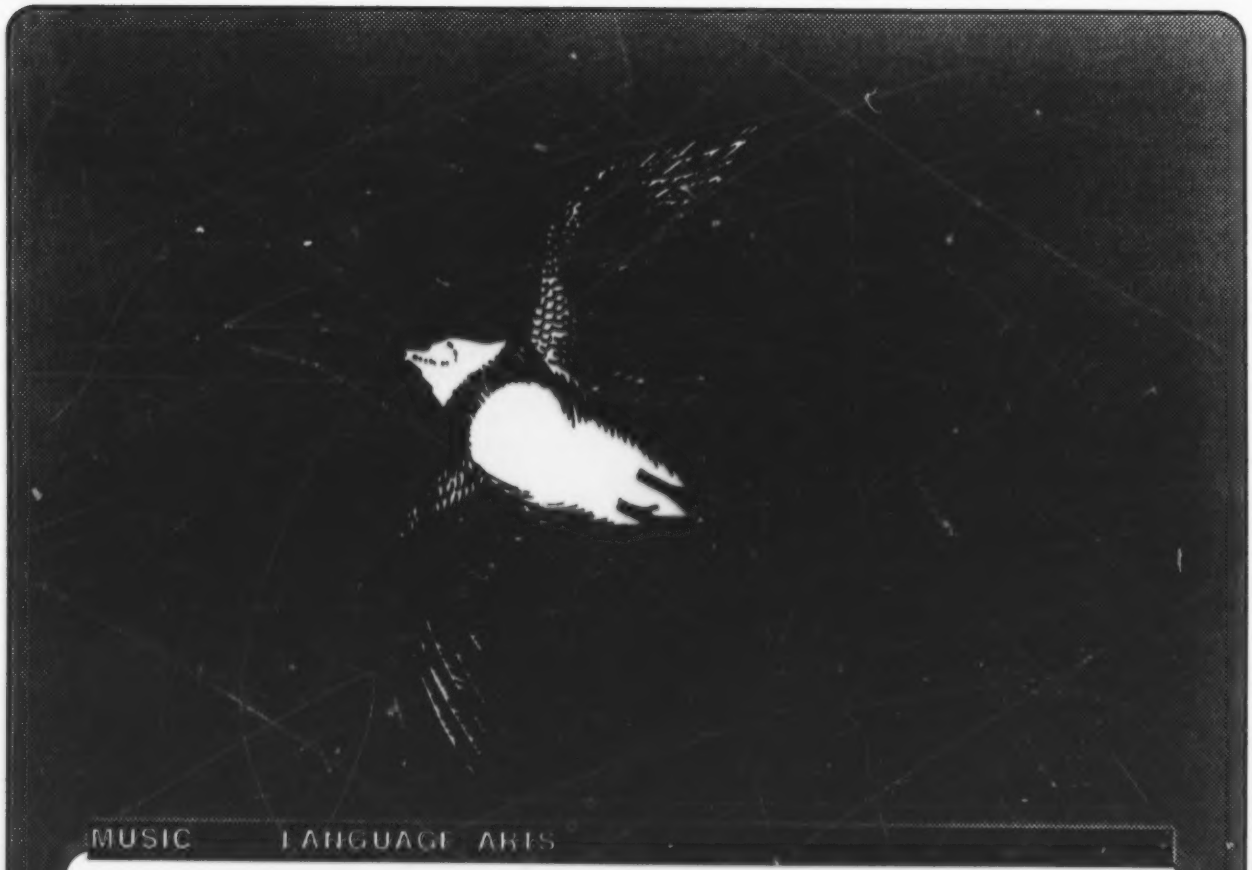
2. Draw a picture of the ecosystem you see on the half of your paper labeled "A Wild Ecosystem". First draw and color the non-living surroundings. Note and try to show the exact color of the sky, the air, the water, and the soil.

3. Count the number of different kinds of producers (plants and algae) and record this number on the back of the paper. Then draw the producers into your ecosystem picture.

4. Look for animals or their sign. (Make sure you examine the ground for droppings and insects, and plant leaves and stems for signs of browse and for insects). Count up the number of different kinds found and record this on the back of your paper. Then draw these into your pictures. (Use your imagination to draw in pictures of the animals that you found sign of only.)

5. Look for fungi and count and record the different kinds. Add the fungi to your drawing.

6. Turn your paper over. Go to the disturbed site and repeat the above steps.



MUSIC LANGUAGE ARTS

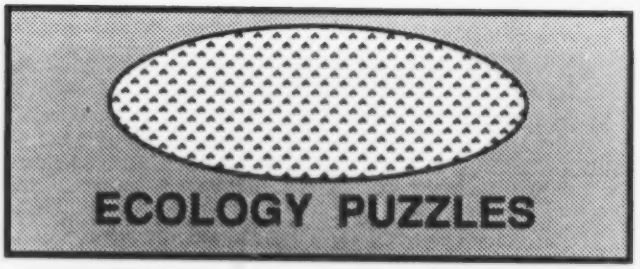
Objectives: Students will strengthen their understanding that all the parts of an ecosystem are important; by comparing an ecosystem to human activities that are based on interdependence.

Materials: Recordings of the sounds of a variety of instruments; a recording of an orchestra (or band) of those instruments playing a symphony (or modern music) (Or, adapt this activity and use apopular recording.)

Procedure: Have students listen to examples of each of the instruments being played individually. Then, ask them to listen to the symphony. Ask students "What instrument played this music? Do they realize the symphony was made by many instruments being played together. Have them listen again and try to pick out the music made by the different instruments being played in the symphony. Could any single instrument make the symphony music? How would the symphony sound if some instruments were removed?

Have the class compare an ecosystem to an orchestra. How are they similar? (All the players (instruments / organisms) are a part of the whole (orchestra / ecosystem)--each does something different, but all are important.) Does the beauty we perceive when looking at a forest, tundra, ocean, or wetland compare at all to the beautiful sounds of a symphony?

Have students write an essay that compares an ecosystem to some human endeavor that requires the participation and help of many--such as a blanket toss, a team sport, or the production of a movie.



ECOLOGY PUZZLES

The following puzzlers are intended to encourage students to think and apply their knowledge of ecology. All of the examples are real world ecology problems. The facts students need to answer the puzzle question are provided. But they must also use their understanding of food webs and chains, mineral cycling, and symbioses in order to address the puzzle question. A brief summary of the observations and opinions of scientists that have studied these ecology problems, along with references, are given on the reverse sides.

ECOLOGY PUZZLER 1

THE FACTS

Sea otters feed on a variety of marine invertebrates, including crabs, clams, mussels, limpets, sea stars, and sea urchins; they also eat some fish.

Crabs, limpets, sea stars, and sea urchins live along rocky, wave-washed coastlines.

Limpets and sea urchins feed on algae and kelp.

Dense stands of algae and kelp can reduce the force of waves, so that floating algae and detritus are trapped and deposited.

Amphipods, isopods, and some shrimp live in dense kelp beds and feed on algae and detritus.

Many predatory fishes feed on amphipods, isopods, and shrimp.

Sea otter populations were reduced to near extinction due to overharvest, but due to protection, their populations have fully recovered in most of Alaska.

THE PUZZLE

Explain how you think the aquatic ecosystem might have changed when sea otter populations were removed. What changes might have occurred when sea otters became re-established?

ECOLOGY PUZZLER 2

THE FACTS

DDT is a pesticide used to kill insect pests. It was widely used on farmlands (to kill insects that ate crops) and on wetlands (to kill mosquitos) in the Lower 48 and Europe from 1946 until1969, when its use was outlawed in the U.S., Canada, and most European countries. It is still being used extensively in South America.

DDT is very poisonous to most living things, including humans. Concentrations of less than 10 parts per million cause birds to lay thin-shelled eggs that easily break when incubated by the parent.

When used to control insect pests, DDT is sprayed on plants from the air.

Because DDT molecules are not very soluble in water, but do dissolve in oil, most living things are not able to excrete DDT in waste materials. Instead it is stored in fat and tissues.

DDT is broken down extremely slowly, if at all, by detritivores and weathering. Thus, any DDT applied to the environment continues to exist and remains poisonous for decades.

THE PUZZLE

Based on what you know about ecology, why is DDT now found in nearly all living things, including penguins in Antarctica, humans in Alaska and in other areas where it was never used?

More to think about

Peregrine falcons prey on small birds, particularly shorebirds and ducks.

Migratory birds that nest farther north tend to migrate farther south in winter.

Another Puzzle

Why do you think that peregrine falcons nesting in northern Alaska continued to have poor nesting success, after the few remaining falcons in the Lower 48 appeared to be having improved nesting success?

ECOLOGY PUZZLER 1

WHAT ECOLOGISTS HAVE PUZZLED OUT

There were no studies of the marine ecosystems prior to extirpation of sea otters, so the effects of removing them are not certain. In some areas where sea otters were extirpated, it appears that populations of sea urchins and limpets increased. These herbivore populations then reduced the amount of sessile algae and kelp growing in nearshore waters. In one study in the Aleutian Islands, Alaska, biologists recorded changes in the ecosystem that occurred following re-establishment of sea otter populations. The sizes and populations of limpets and sea urchins, both grazing herbivores, were reduced due to sea otter predation. This reduction in grazing pressure allowed dense stands of kelp and algae to develop. These stands tended to reduce the force of wave action, and trapped silt and detritus. Siltation made the substrate less suitable for sessile organisms (such as limpets and mussels) that attach to rock surfaces. But it provided a good environment for filter -feeding herbivores (that eat detritus and algae floating in the water) such as amphipods, isopods, and shrimp. These in turn provided food for predacious fishes, so these moved into the area.

However, the changes observed in the area studied do not always occur. A wide variety of factors, including the force of the incoming waves, the substrate, and the relative abundance of the various producers and herbivores combine to cause different kinds of ecosystem responses in other areas. High sea otter populations have been observed to depress populations of certain prey (including sea urchins, crabs, and abalones) in other areas.

References:

Palmisano, J. F. and J. A. Estes. 1977. Ecological interactions involving sea otters. pp. 527-567. In M. L. Merritt and R. G. Fuller (eds.) The environment of Amchitka Island, Alaska ERDA, Oak Ridge. (NTIS no. TID-26712).

ECOLOGY PUZZLER 2

WHAT ECOLOGISTS HAVE PUZZLED OUT

DDT is now found in living things around the world because it was spread in the atmosphere by winds, deposited with rains; particles were washed away in run off waters into into rivers, lakes, and oceans,where it was further spread by ocean currents. Since DDTdoes not break down, repeated applications of the chemical built up. A marsh in New York that was sprayed with DDT for 20 years had DDT residues amounting to 32 pounds per acre! Almost all the DDT ingested by a living thing remains in its system, and concentrates in tissues and fats. A herbivore that eats a producer with DDT in it, retains all the DDT and stores it in its system. It is easy to see that a carnivore, after eating dozens of herbivores--each with a small store of DDT--ends up with a much higher concentration of DDT than any of its prey. Top carnivores that eat contaminated carnivores concentrate the poison even further--and end up with toxic concentrations. For example in the marsh mentioned above, plankton in the water had concentrations of .04 parts per million (ppm), while minnows had 1 ppm, and a gull (a carnivorous scavenger) had 75 parts per million in its body.

Since DDT use has been halted in the Lower 48 for over 15 years, the concentrations of DDT in the environment is decreasing--as it is spread by winds and water over a larger and larger area. Additionally, some is becoming trapped in the bottom of lakes, and on the bottom of the ocean. Thus, the amount of DDT accumulation by food chains is decreasing in the Lower 48. Peregrines that nest in northern Alaska continued to accumulate high concentrations of DDT even after DDT use in North America was banned because in winter they migrate to South America where the poison was (and is) still used and was still accumulating through food chains. In addition, their main prey, shorebirds, also migrate to South America where they pick up pesticides. Thus, Alaska peregrines may accumulate DDT even in summer when they are in the arctic, thousands of miles from the areas where DDT is still in use.

References: Woodwell, G. M. Toxic substances and ecological cycles. Scientific American. March 1967. and U.S. Fish and Wildlife Service, Endangered Species Section, Fairbanks, AK

ECOLOGY PUZZLER 3

THE FACTS

The radioactive isotope cesium 137 is a product of atomic fission reactions, such as the explosion of nuclear weapons. It has a half-life of 30 years, which means that it loses half of its radioactivity every 30 years. (Thus after 60 years, it still has 1/4 of its original radioactivity, and after 90, it has 1/8 its original radioactivity.)

Cesium 137 has been released into the atmosphere by the explosion of atomic weapons in the south Pacific, China, Russia, Japan.

The effects of radiation from radioactive materials on living things depends on a large number of variables. A critical variable is the concentration or intensity of the radiation. Prolonged exposure to even low levels of radiation can cause cancer and other diseases in living things.

Lichens obtain the minerals they need from rain water.

Cesium 137 has chemical properties that make it react with other chemicals in ways similar to potassium.

Potassium is an essential mineral of the cells of living things.

THE PUZZLE

Based on what you know about ecology, explain why you think some humans living in arctic regions have had concentrations cesium137 in their tissues over 3 times the concentration found in precipitation.

ECOLOGY PUZZLER 4

THE FACTS

Plastic is a material made from fossil fuels. It can not be broken down or decomposed by living things.

Much of the plastic produced begins as small bits or particles which are then shipped to plants around the world for melting and formation into desired plastic products, such as toys, buckets, bags, food wrap, cups, gadgets, etc. Major plastic manufacturers are located in California, and in Japan and other Asian countries. Alaska did not have any plastic manufacturers until 1985.

Some of the plastic particles made by the producers are accidentally lost in shipping accidents. Plastic materials are also dumped in the ocean by ocean going vessels, fishermen, and others. The National Academy of Science estimates that over 300 million pounds of plastic are dumped in the ocean every year.

Plastic particles float on the surface of the water.

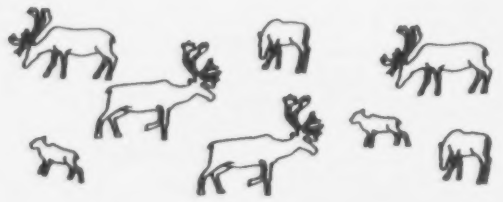
The currents of the Pacific Ocean move in a counter-clockwise direction southeast past Japan toward the California coast, northwest past British Columbia and southeast Alaska, then southwest past the Aleutian Islands.

Many seabirds, including shearwaters, storm-petrels, auklets, and puffins feed on small zooplankton and cephlapods that float near the ocean surface.

Zooplankton and cephlapods are, in general, too small to ingest plastic particles. They feed mainly on algae and smaller zooplankton.

THE PUZZLE

Based on your knowledge of ecology, would you expect to find plastic in the stomachs of Alaskan seabirds? Explain why or why not.



ECOLOGY PUZZLER 3

WHAT ECOLOGISTS HAVE PUZZLED OUT

Atmospheric testing and explosions of atomic weapons sent cesium-137 and other radioactive isotopes high into the earth's atmosphere. They are spread widely and quickly by the air currents. The isotopes are eventually washed out of the atmosphere by rain, and deposited on vegetation, land, and water. In part due to the patterns of air circulation, and in part due to the earth's magnetic fields, more cesium-137 has been deposited in arctic regions than elsewhere. Lichens are a dominant producer in the arctic. These symbiotic organisms get most of their nutrients from rainwater, so they absorbed much of the cesium-137 that has been deposited. During winter, caribou eat mainly lichens. All the cesium-137 in the lichens they ate become concentrated in their body tissues and fluids. Some caribou that were examined had concentrations of 15 micromicrocuries of cesium-137 per gram of tissue. Humans who eat caribou again concentrated the cesium-137 and ended up with concentrations of 30 micromicrocuries per gram of tissue. Wolves and foxes that fed on the caribou sometimes contained 45 micromicrocuries of cesium-137 / gram of tissue. The health risks of this concentrated exposure are poorly known.

References: Hansen, W. C. 1967. Cesium-137 in Alaskan Lichens, caribou, and eskimos. Health Physics 13:383-389.

Environmental Radioactivity. Merril Eisenbud. McGraw-Hill Book Co. Inc. 1963.

ECOLOGY PUZZLER 4

WHAT ECOLOGISTS HAVE PUZZLED OUT

Even though there were no plastic manufacturers in Alaska until 1985, plastic particles have been found in Alaskan seabirds! Plastic particles have been found in the digestive tracts of 21 of the 37 species of Alaskan seabirds examined. In some species, 40-50% of the birds examined had plastic in their digestive tracts! The puffins, auklets, storm-petrels, fulmars, and shearwaters that have the plastic particles feed mainly on crustaceans and cephalopods (squid) which are too small to ingest the plastic particles. Scientists do not know why seabirds are picking up the plastic, but hypothesize that the birds are mistaking the plastic particles for zooplankton or fish eggs. Different species of birds seem to pick up different kinds of plastic particles.

Alaskan seabirds find and ingest the particles on their migrations through waters off Japan and California where plastic manufacturing occurs, and in some Alaskan waters where plastic particles have become concentrated as a result of ocean currents. A visit to any outer coast beach of Alaska will quickly show that industrial plastic pollution is not the only source of the problem. The beaches are littered with plastic of all descriptions.

The plastic particle problem is just being recognized and appears to be a recent phenomenon, at least in Alaska. Parakeet auklets of St. Lawrence Island in the Bering Sea did not have any plastic particles in their digestive tracts in the mid-1960's. By the mid-1970's, 50% of the birds in the area contained plastic. The effects of the plastics on the seabirds are unknown. There is some evidence that seabirds with digestive tracts packed with plastic may have trouble digesting food, or may starve.

A recent report by the National Academy of Sciences indicated that worldwide, an estimated 1-2 million birds and 100,000 marine mammals may die each year as a result of plastic pollution, but this figure refers mainly to birds and mammals that become entangled in discarded or lost commercial fishing nets and lines.

References:

Day, R. H. 1980. The occurence and characteristics of plastic pollution in marine birds. Master's Thesis. University of Alaska. 111 pp.

Wehle, D. H. S. and F. C. Coleman. 1983. Plastics at sea. Natural History. February 1983. pp. 20-26.

ECOLOGY PUZZLER 5

THE FACTS

Most of the energy and nitrogen available to stream food chains comes from leaf litter from streamside trees and shrubs and upstream wetlands. A small amount of energy is also made available by aquatic producers--such as algae and aquatic plants.

The main herbivores in stream ecosystems are aquatic insect larvae, such as caddisflies, mayflies, and blackflies. These organisms filter detritus and algae that float past in the water.

Insect larvae are the main food for fish, such as salmon fry, sticklebacks, whitefish, and grayling. Most of these fish locate their prey by sight.

The amount of oxygen dissolved in stream water is determined by the speed the water is traveling and the temperature of the water. Fast-flowing, cold water carries much more oxygen than slow-moving warm water.

Stream-associated birds include kingfishers, mergansers, and osprey. These birds feed mainly on fish which they locate by sight. Another bird, the dipper, feeds mainly on aquatic insects. It locates these by sight also.

The temperature of the stream water is affected by the amount of solar radiation that reaches the stream. Streamside vegetation shades the stream.

Stream-associated mammals include river otters, mink (both of which feed mainly on fish) and beaver (which feed on streamside shrubs and trees).

Salmon, grayling and other fish lay their eggs amidst gravel on the stream bottom. Spaces in the gravel provide a place safe from predators for the eggs and alevin to develop. Water flowing between the gravel particles delivers a continuous supply of dissolved oxygen.

Placer mining, the main gold mining method used in Alaska, involves removing streamside vegetation, then washing the gravel and soil of a stream bed and adjacent areas with water. In the washing process, gold, which is heavier than other materials, settles out first. Other dirt particles and minerals are carried away by the stream. These cloud the stream water, and slowly settle out to cover the stream bottom with silt.

THE PUZZLE

Based on your knowledge of ecology, predict how placer mining affects stream ecosystems.

ECOLOGY PUZZLER 6

THE FACTS

Billions of years ago, the earth's atmosphere contained little or no free oxygen, but contained much more carbon dioxide than it does today. Today it is made up of 79% nitrogen, 21% oxygen, 0.9% rare gases, and 0.03% carbon dioxide. Scientists hypothesize that the carbon dioxide that was orignally in the atmosphere was converted into carbon chains by photosynthetic organisms. Oil, coal, and gas are all made of the ancient remainsof living organisms. Most of the carbon on earth is now tied up in these fossil fuels, in deep sea sediments, and in wood.

The processes of photosynthesis and respiration have balanced each other out for millions of years. The amount of carbon dioxide in the atmosphere has remained at about 0.03% for millions of years (as far as scientists can tell).

The atmosphere not only provides the oxygen we breathe, and the carbon dioxide needed by photosynthetic organisms, it also affects the climate of the earth by absorbing and reflecting light energy. Light is reflected by dust in the atmosphere. Carbon dioxide, unlike most other portions of the atmosphere, absorbs heat from the sun's rays.

Worldwide, forests are being cut down (for wood products, fuel, and to make room for farmland, industry, and cities) at the rate of about18--20 million hectares (7.2 - 8 million acres) per year.

Currently, combustion of oil, gas, coal, and wood release 5-6 billion tons of carbon dioxide into the atmosphere annually. Combustion also releases heat into the atmosphere.

The amount of dust in the air is increased by volcanic eruptions, combustion of fossil fuels and wood, pollution, wind erosion of land where vegetation was removed.

THE PUZZLE

Use your knowledge of ecology and the above facts to predict whether the earth's climate is likely to warm, cool, or stay the same. If you predict it will change, explain why, and what you expect some of the effects of this change will be.

ECOLOGY PUZZLER 5

WHAT ECOLOGISTS HAVE PUZZLED OUT

Placer mining severely disrupts stream ecosytems. The most serious problem are the sediments in the water. These affect nearly all the living things present. The increased turbidity (cloudiness) reduces the amount of light available for producers such as algae. It prevents predators that use vision to locate their prey (fish, mammals, and birds) from finding and capturing food. It clogs up the feeding mechanisms of filter feeding organisms. It abrades the gills of fish thus interfering with their ability to breathe. The fine grain particles that settle out fill up the air spaces between gravel particles. This smothers the eggs and alevin that live in these spaces.

Removal of streamside vegetation results in a reduced amount of leaf litter and thus less energy is available for all organisms in the food chain. This may not be a serious problem at the site of the placer mine if upstream vegetation remains intact. However, it affects ecosystem production below the mine site. Removal of streamside vegetation may also result in increased water temperatures (due to reduced shading) and thus decrease the amount of oxygen available to aquatic organisms. Removal of the streamside vegetation also results in soil erosion, in addition to the sedimentation caused by the mining itself. This erosion continues until vegetation is re-established; thus, increased sedimentation may continue to be a problem long after the mining operation is over.

The amount of turbidity and sedimentation caused by placer mining can be significantly reduced by constructing a series of settling ponds. Turbid water is stored in the settling ponds temporarily to allow some of the sediments to settle out; only then is it returned to the stream. Settling ponds can be difficult and expensive for a miner to build and maintain.

References: J. LaPerriere. Alaska Cooperative Fisheries Research Unit. University of Alaska. Fairbanks.

ECOLOGY PUZZLER 6

WHAT ECOLOGISTS HAVE PUZZLED OUT

The amount of carbon dioxide in the atmosphere has been increasing at the rate of 0.2% per year since about 1850 and this rate is currently accelerating. The amount of dust in the atmosphere has also been increasing. Scientists agree only that we humans are conducting a gigantic ecological experiment with the earth as the test tube. Most scientists agree that the increased amount of carbon dioxide is going to result in something happening.

Some ecologists predict that the increased amount of carbon dioxide will trap more heat from sunlight (in addition to the additional heat released by combustion) which will cause a warming of the earth's climates. This is called the "greenhouse" effect. They predict this would result in melting of the polar ice caps, which would raise the level of the oceans by several feet and flood much of the land that is currently inhabited by people. It would also flood or change the climate in most of the lands where food crops for humans are raised.

Other ecologists predict that due to the increased amount of dust in the atmosphere, the earth's atmosphere will reflect more sunlight, and absorb less which will result in a cooling of the climate and another ice age.

A moderate change in the climate of the earth, in either direction, would result in major difficulties for humans and most living things.

Some scientists suggest that there will be no change because the increased amount of carbon dioxide in the atmosphere will allow more photosynthesis by producers, which will counteract the build up of carbon dioxide. The problem is complicated by the chemical reactions to various pollutants of many other atmospheric gases, such as ozone.

References: U. S. Council on Environmental Quality and Dept. of State. 1982. The Global 2000 Report to the President. Penguin Books. New York.

B. Bolin. 1970. The Carbon Cycle. Scientific American. September 1970.

A GUIDE TO THE FIVE KINGDOMS OF LIVING THINGS

The information below is provided as background information for teachers on the 5 major groups of living things--their characteristics and ecological roles. This 5 kingdom classification has replaced the older division of living things into two kingdoms--plants and animals. See the poster that accompanies this packet for illustrations of representative organisms. (Much of the information presented in this table was modified from "Biology," 4th ed., by Helena Curtis, Worth Publishers, New York.)

Kingdom Monera

This kingdom includes the smallest and most primitive living things, bacteria and cyanobacteria (formerlly called blue-green algae). All monerans are made up of only one cell. Some monerans live together in colonies (as filaments for example) and thus may superficially appear to be multicellular organisms. These microscopic organisms are differentiated from all other living things by the lack of a cell nucleus. The genetic material of monerans floats freely in their cell fluids. They do not have mitochondria or chloroplasts. Most monerans absorb their foods (nutrients), but some are capable of photosynthesis. Most monerans reproduce asexually by fission or budding. Monerans are very important ecologically as decomposers; cyanobacteria are important producers. Many monerans are symbionts with other living things. Certain bacteria live in the intestinal tracts of animals and help digest foods, or produce needed nutrients. Some bacteria live in or on the roots of plants and help them absorb nutrients from the soil. Some cyanobacteria and fungi form lichens. Some bacteria cause diseases in plants and animals..

Kingdom Protista

This kingdom includes nearly all other single-celled organisms (including algae and protozoans), slime molds (which have many cell nuclei with in a single cell) and multicellular algae (the seaweeds or kelp). (Brown, green, red, golden-brown, and fire algae; diatoms and dinoflagellates belong to this kingdom). This kingdom includes only organisms with a cell nucleus. Algae (both single celled and multicellular) are very important producers, particularly in aquatic ecosystems. Some protozoans can do photosynthesis, while others are consumers; some protozoans obtain nutrients using photosynthesis and by consuming other living things. Protists move by use of flagella, cilia, or pseudopodia; some kindsdo not move from place to place.

Kingdom Fungi

This kingdom includes organisms that have a cell nucleus. Most are made up of filaments of cells, but a few aresingle-celled. It includes mildews, morels, truffles, mushrooms, toadstools, shelf fungi, yeasts and molds. Lichens are made up of a fungi living together with an algae or cyanobacteria. All fungi obtain food (nutrients) by absorbing it. Many fungi are extremely important as decomposers. They give off certain enzymes that break down organic material (dead organisms and waste materials), then absorb the nutrients broken down by their enzymes. Other fungi, particularly mushrooms are very important because of their symbiotic relationships with plants, or mycorrhizal. Mycorrhizal fungi live on or in the roots of plants and in exchange for nutrients from the plant root, they help the plant absorb minerals from the soil. Other fungi are parasitic, on plants or animals (athlete's foot for example). We often just see the reproductive part of fungi (for example, a mushroom); the main part, tiny thread-like extensions called hyphae, extend inside and through the wood, soil, leaf litter, roots, or other material on which the fungi is growing. Fungi reproduce asexually by spores, and sexually.

Kingdom Plantae

This kingdom includes mosses, liverworts, ferns, horsetails, conifers, and flowering plants. These organisms are characterized by having cells with nuclei and a cell wall; and the highly organized arrangement of their many cells. All are capable of photosynthesis, and most are green. All except the mosses and liverworts have leaves, roots, and stems and a system for transporting water and organic materials among the many cells. Plants are extremely important ecologically in their role as the major producers in terrestrial ecosystems. All plants live a stationary life.

Kingdom Animalia

This kingdom includes sponges, jellyfish, hydra, and anemones; flatworms; molluscs (snail- and clam-like organisms, chitons and octopi); segmented worms; other worms; arthropods (horseshoe crabs, spiders, crabs shrimp, centipedes; millipedes and insects); bryophytes (moss animals); starfish, sea urchins, and sea cucumbers; lamprey, sharks, rays, fish, amphibians, reptiles, birds, and mammals. These are all characterized by having cell nuclei, lacking a cell wall, and the highly organized arrangement of their many cells. All animals obtain energy and minerals by eating other living things; they are consumers. Most animals move around a lot.

ALASKAN FOOD CHAIN AND FOOD WEB EXAMPLES

Six food chain examples for forest, tundra, wetland and ocean are shown in bold letters. Make food webs by using the other foods of each living thing (listed in small letters below its name) to find other interconnections. Use with the activities in Lessons 1, 2, and 3 of this unit. Use information provided on the back of the photo poster (from this and Alaska Wildlife Week Units 1, 2, & 3--check your library). See the 1984 unit for more background on wetland food webs.

	*PRODUCER	HERBIVORE	CARNIVORE 1	CARNIVORE 2	DETRITIVORE
FOREST	1. White Spruce	**Red Squirrel** berries, mushrooms	**Marten** voles, bird eggs		**Mushroom** any dead plant
	2. Willow	**Snowshoe Hare** birch, grass, fireweed	**Lynx** voles, squirrels		**Raven** any dead animal
	3. Grass Seeds	**Red-backed Vole** berries, fireweed	**Boreal Owl** flycatcher, woodpecker		**Fly** any dead animal
	4. Lingonberry	**Pine Grosbeak** spruce and birch seeds	**Goshawk** squirrel, flycatcher, woodpecker		**Bacteria** any dead thing
	5. Fireweed	**Moth**	**Alder Flycatcher** flies, beetles	**Merlin** pine grosbeak	**Beetle** any dead animal
	6. White Birch	**Bark Beetles** spruce	**Downy Woodpecker** moth, berries		**Shelf Fungus** any dead wood
TUNDRA	1. Lichen	**Caribou** dryas, willow, sedge	**Brown Bear** sedge, grass, blueberry		**Bacteria** any dead thing
	2. Dryas	**Dall Sheep** willow, sunflower, sedge	**Wolf** caribou, marmot		**Raven** any dead animal
	3. Willow	**Redpoll** willow, sunflower, sedge	**Arctic Fox** singing vole, any dead animal		**Flies** any dead animal
	4. Grass	**Singing Vole** sedge, sunflower, dryas	**Short-tailed Weasel** redpoll		**Springtail** any dead plant
	5. Sunflower	**Butterfly** blueberry, mountain avens	**Golden Plover** flies, springtail, blueberry	**Jaeger** redpoll, vole	**Bacteria** any dead thing
	6. Sedge	**Marmot** grass, sunflower	**Wolverine** fox, any dead animal		**Mushroom** any dead plant
	7. Blueberry	**Willow Ptarmigan** willow, sedge	**Golden Eagle** marmot, weasel, sheep (lamb only)		**Fly** any dead animal
WETLAND	1. Algae	**Water Fleas** dead plants, protozoans	**Stickleback** midge, rotifer	**Common Loon** frog	**Bacteria** any dead thing
	2. Pondweed	**Pintail** algae, seeds of sedges	**Peregrine Falcon** phalarope		**Rotifer** any dead producer, protozoans
	3. Algae	**Midge** algae, dead plants	**Wood Frog** flies, mosquitos	**Sandhill Crane** stickleback, sedges	**Water Flea** any dead producer, rotifer
	4. Sedges	**Muskrat** pondweed	**Mink** stickleback, phalarope		**Bacteria** any dead thing
	5. Willow	**Moose** willow, sedge	**Wolf** muskrat, pintail		**Flies** any dead animal
	6. Algae	**Mosquito Larvae** protozoans	**Red Phalarope** midge, water flea, rotifer	**Parasitic Jaeger**	**Protozoans** any dead material, algae
OCEAN	1. Green Algae	**Sea Urchin** kelp	**Sea Otter** crab, sculpin, sea star		**Tanner Crab** any dead animal
	2. Kelp	**Snails** green algae	**Sea Star** sea urchin, sea cucumber, shrimp		**Flatfish** any dead animal, snails, fish
	3. Diatom (algae)	**Amphipod** other algae, kelp	**Sculpin** shrimp, sand lance	**Sea Anemone** sand lance, snails	**Shrimp** any dead material
	4. Sea Grass	**Brant** green algae	**Bald Eagle** herring, guillemot, any dead animal		**Marine Worm** any dead plant, algae
	5. Brown algae	**Copepods** other algae, sea grass	**Sand Lance** amphipod, euphausids	**Pigeon Guillemot** sculpin, herring	**Sea Cucumber** any dead thing
	6. Red algae	**Euphausids** other algae, diatoms	**Herring** copepods, sand lance	**Harbor Seal** sand lance, flatfish	**Gull** any dead animal

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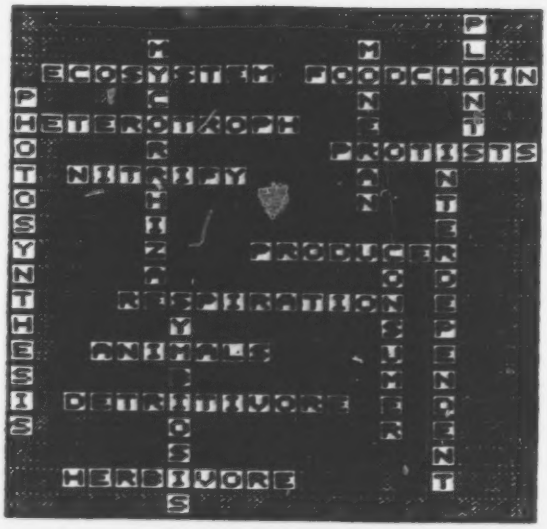
WORKSHEET SOLUTIONS

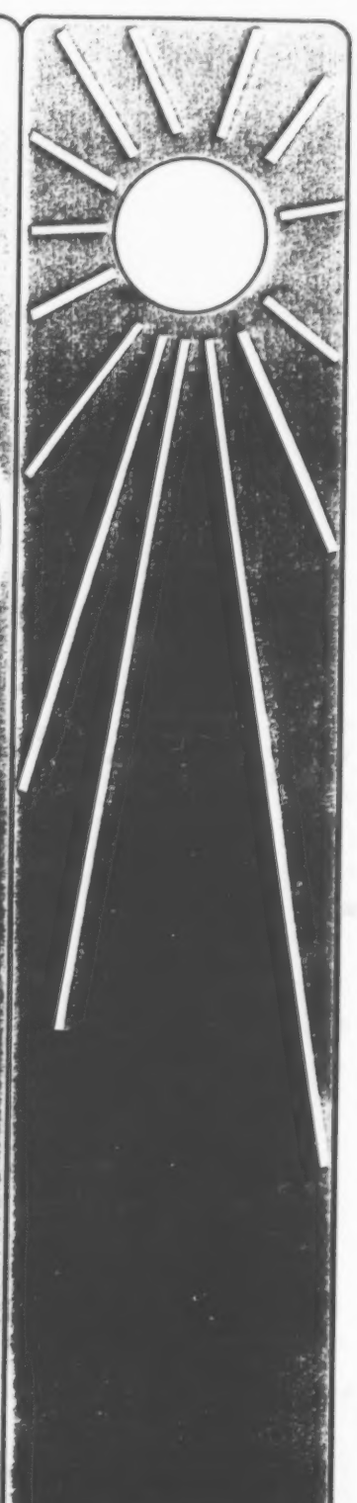


NON-LIVING SURROUNDINGS

ROCKS AND DIRT

WATER

AIR



ENERGY

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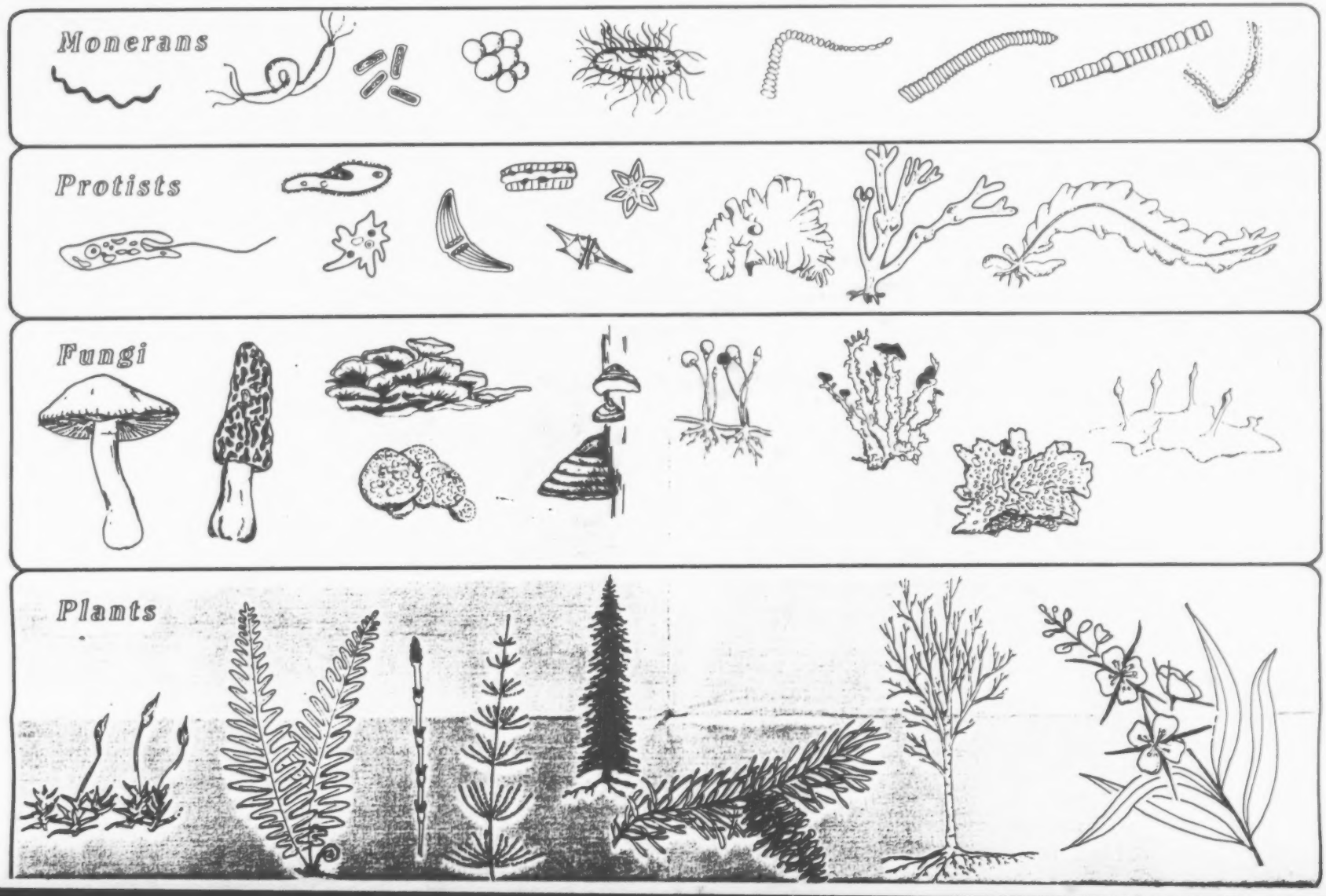
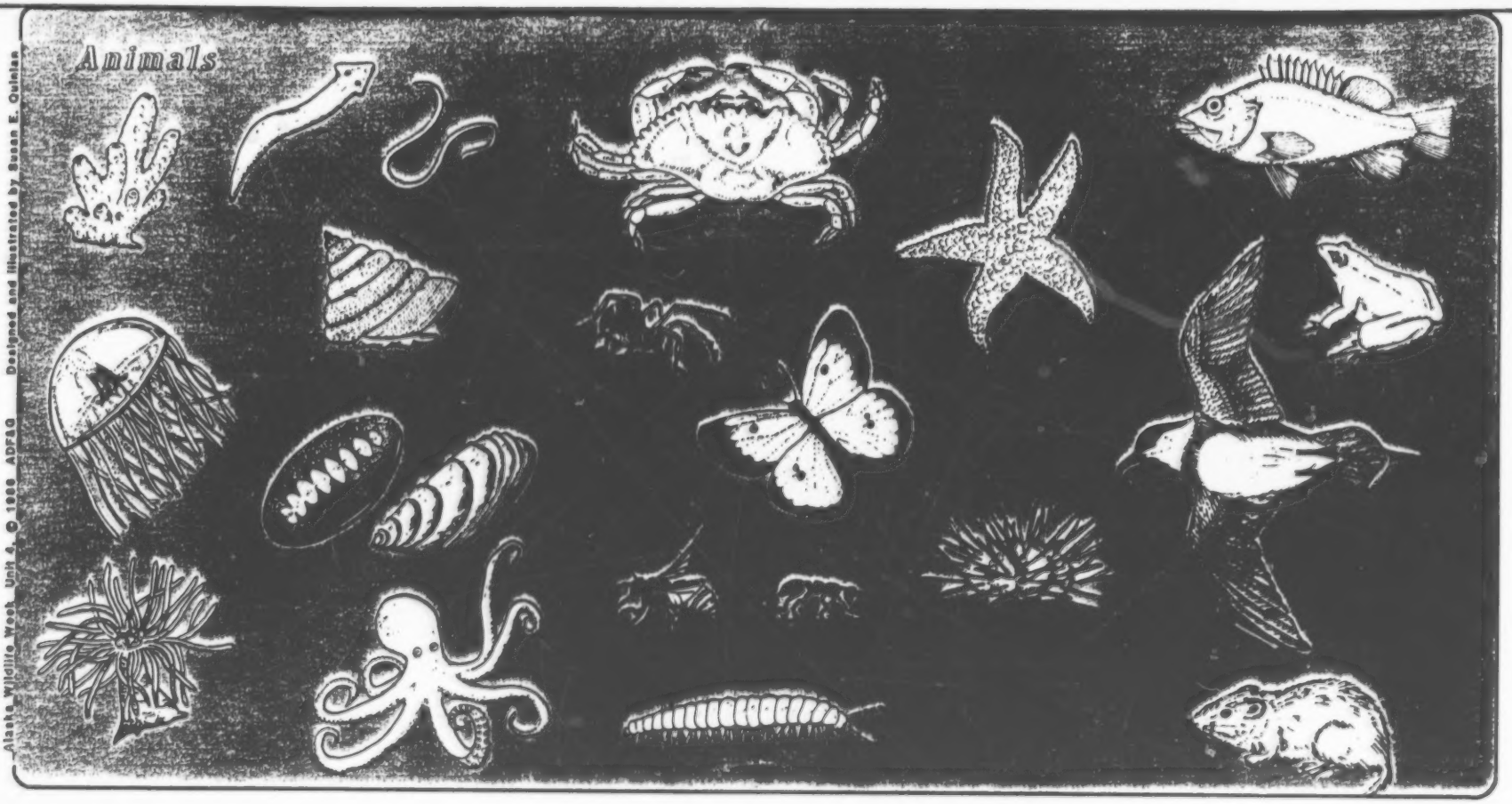
LIVING THINGS





LIVING THINGS CHART CONTINUED

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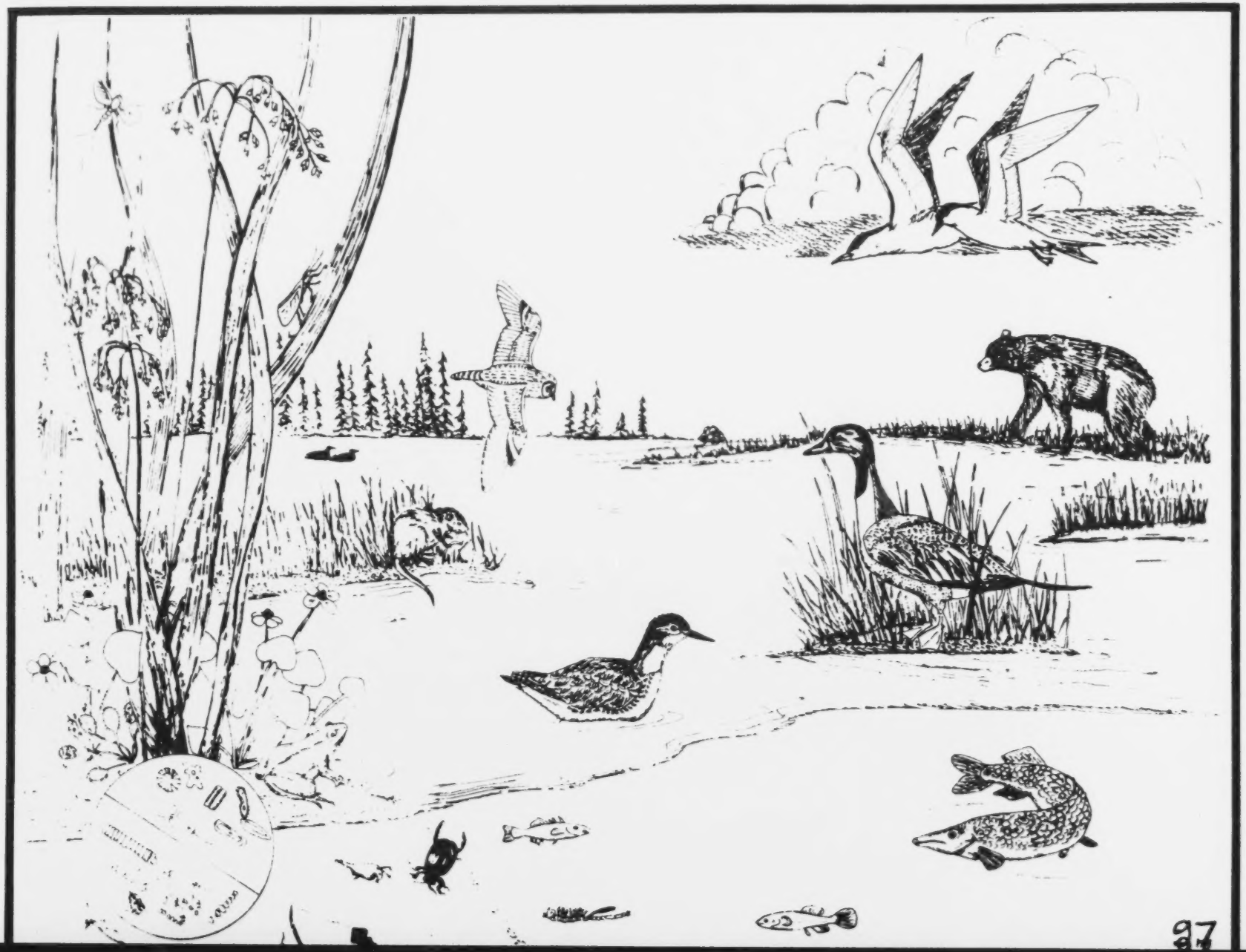
Alaskan



Ecosystems

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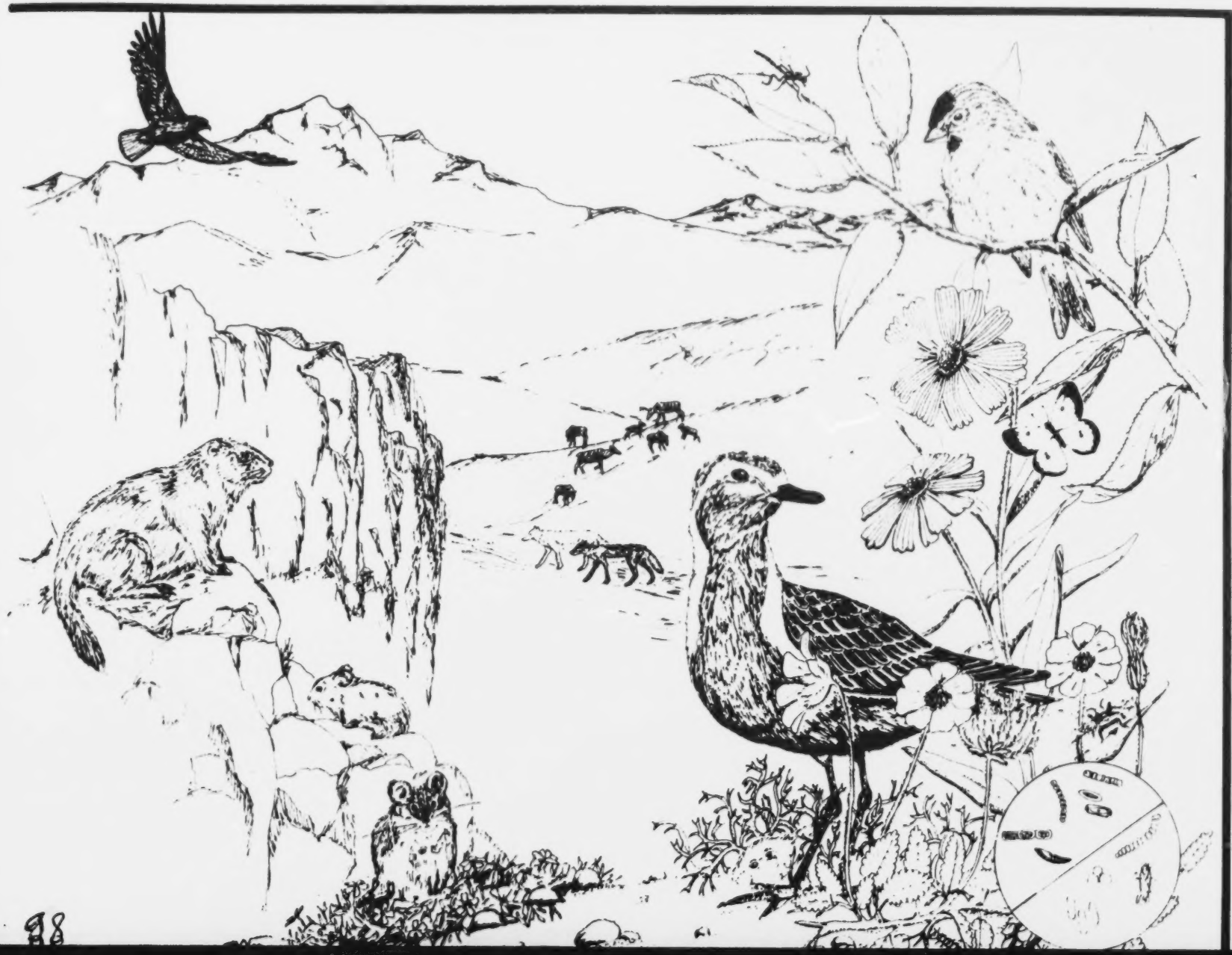

Forest

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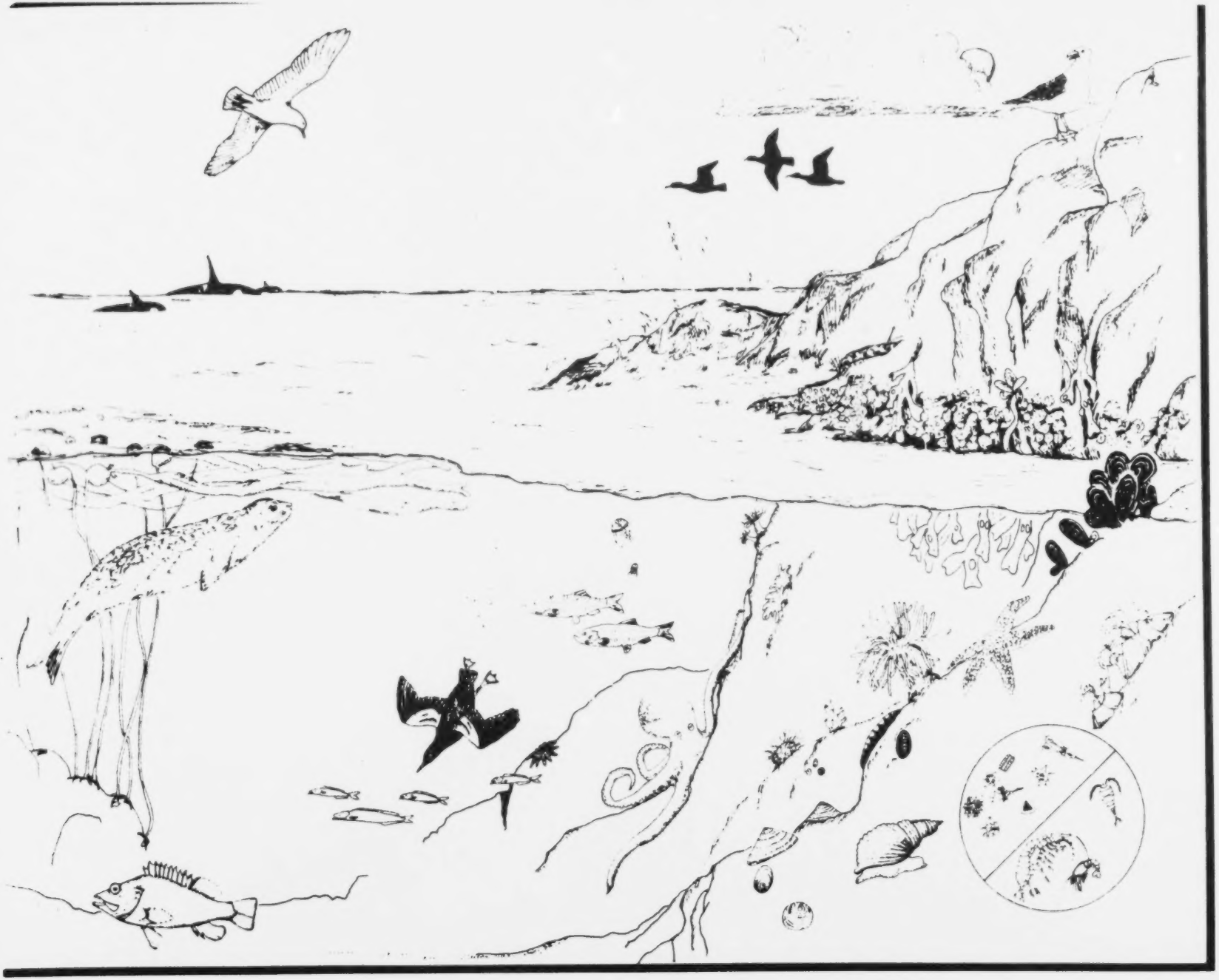

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D. Simpson

W. Lehnhausen

DWARF DOGWOOD *Cornus canadensis*

Dwarf dogwood grows on the ground in boreal forests throughout North America. Its flowers are white to greenish-white and it produces bright red berries. The leaves of this small plant are arranged in a circular pattern, or whorl.

Like other plants, dogwood makes its own food through photosynthesis and takes up minerals from the soil. Dogwood grows best in moist areas beneath the shelter of a forest canopy where sunlight is filtered. Dogwood relies on insects to pollinate its flowers, and on small mammals and birds to eat its berries and carry its seeds to new areas. Dogwood seeds may need to pass through the digestive tract of an animal before they can germinate.

PHOLIOTA *Pholiota spp.*

These whitish mushrooms are the fruiting body of a kind of fungus. This portion of the fungi produces spores which can grow into new fungi. The main body of the fungi is made up of long thin strands of tissue, called hyphae, that grow underground. The fungal hyphae spread enzymes into their surroundings. These enzymes, like those in the stomach of an animal, digest, or break down the fungi's food—mainly dead plant material, or detritus. The hyphae absorb some of this pre-digested food. These fungi grow in moist ground where their hyphae can grow through and digest dead plant material.

Some Pholiota fungi hyphae penetrate tree roots. The hyphae find shelter and moisture and help the tree roots absorb various minerals that they could not otherwise. This is called a micorrhizal association. Many trees could not grow without the help of such micorrhizal fungi. Small mammals eat the mushrooms and carry their spores through the forest. Thus, they help both fungi and trees.

HAIRY WOODPECKER *Picoides villosus*

Hairy woodpeckers are 1 of 6 species of woodpeckers that occur in Alaska. They are identified by the white stripe down their back and their relatively large size. They are 8-10 in (20.3-25.4 cm) long, have a 15-17 in (38.1-43.2 cm) wingspan, and weigh about 2½-3½ oz (65-100 gms). They occur year-round in coniferous and hardwood forests throughout North America.

FOOD—Hairy woodpeckers sense the movements of wood-boring insects (such as bark and longhorn beetle larvae) by sounds or vibrations. They dig these, their main foods, out from tree trunks and branches with their sharp chisel-like bill. Seeds, berries, and other kinds of insects are also eaten.

WATER—They obtain water from dew, puddles, snow, and their food.

COVER—Woodpeckers require dead trees, or snags, with wood softened by fungi in order to dig out nesting and roosting cavities. They dig new cavities each year.

SPACE—Each pair defends a territory of about 30 acres (12 ha) of forest.

ARRANGEMENT—Hairy woodpeckers need several trees suitable for excavating nesting and roosting cavities within a forest with adequate populations of wood-boring insects.

- Only male hairy woodpeckers have the red spot on the nape of their neck as shown in the photo. Excepting this difference, male and female look alike.
- Old woodpecker holes are used by a variety of cavity-nesting birds, including chickadees, nuthatches, swallows, small owls, and kestrels.

ROCKWEED *Fucus spp.*

This is a kind of kelp, or seaweed. Seaweeds are a kind of algae that can be seen without a microscope. Some grow several feet long. Algae are sometimes considered a kind of plant, but most scientists now place them in a separate group of living things, called protists. Seaweed and algae are the producers in ocean ecosystems. Like plants, they photosynthesize food and give off oxygen. Some crustaceans eat seaweed, and a variety of living things hide in it.

BLUE MUSSEL *Mytilus edulis*

This invertebrate is a mollusk. It lives along rocky sea coast in northern areas around the world. It occurs in the Pacific from Baja California to the Arctic Ocean. Its purplish-blue shell may grow as large as 3½ in (9 cm). It attaches itself to rocks with strong, glue-like threads, called byssal threads. Mussels feed by filtering tiny invertebrates, algae, and other microscopic living things out of seawater. They are eaten by a variety of other animals, including gulls, crows, scoters, otters, some fish, and sea stars. Blue mussels also provide barnacles, hydroids, and bryozoans with places to hide and live.

ACORN BARNACLE *Balanus spp.*

These white-shelled invertebrates are actually related to shrimp. The hard white shell protects them from some predators, and allows barnacles to live in the intertidal zone, where they are sometimes in seawater, and sometimes high and dry. Barnacles have appendages, called cirri, that fan out into the water to filter out microscopic living things, including algae and zooplankton. Barnacles are eaten by nudibranchs, snails, sea stars, crows, black bears, and diving ducks (scoters, harlequins, goldeneye).

YELLOWEYE ROCKFISH *Sebastes ruberrimus*

Yelloweye rockfish are an ocean-dwelling fish that live near the sea floor along rocky shores, reefs, and under water ridges and boulder fields from Baja California to the Gulf of Alaska. These fish may grow to 36 in (91 cm) in length and weigh over 20 lbs (9 kg).

FOOD—Their main foods are small fish, including other rockfish, herring, sandlance, and various codfish. They eat small amounts of shrimp and crab.

WATER—Rockfish drink saltwater.

COVER—Larval rockfish need deep water canyons, while adult fish need reefs, boulder fields and rock crevices. Their main predators are other large fish (like halibut, other yelloweye rockfish), and possibly some marine mammals.

SPACE—Rockfish are thought to live most of their lives in a fairly small area; divers see the same adults in the same places every year.

ARRANGEMENT—Food and cover must be located close together.

- Yelloweye rockfish do not begin breeding until they are 15 years old and they may live 100 years or more.
- Rather than laying eggs, the females give birth to tiny fish called larvae. A single female may release several million larvae each year, but very few of these survive to breed.

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J. LaPerriere

ALGAE *Closterium spp.*

This is an individual algae. It is a kind of desmid algae in the genus Closterium. This kind of algae is found in lakes and ponds throughout North America. Thousands of these cells together form a visible green scum in the water. Look at pond water under a microscope to see an individual cell.

Algae are sometimes considered to be plants, but most scientists now place them in a separate group, the protists. Like plants, many algae have chlorophyll and are able to photosynthesize food and produce oxygen. Some algae move around, and some eat other protists in addition to photosynthesizing food. Not all algae are microscopic. Seaweeds are a kind of algae that can be seen without a microscope. Algae are the main producers of food and oxygen in ocean and lake ecosystems.

Algae are eaten by a wide variety of living things, including microscopic organisms, a wide variety of invertebrate animals (snails, sea urchins, limpets, insects, and crustaceans), and some fish and birds.

MOSQUITO *Family—Culicidae*

The organisms shown in the photo are the larvae and pupae of an unknown species of mosquito. Many species of mosquitos occur in Alaska in a wide variety of habitats, including forest, tundra, and wetlands. Mosquito larvae hatch from eggs that adults lay on the water surface or plants. The larvae swim around in water and breathe through a tube that they hold up to the surface and through gills. The larvae usually molt 4 times before developing into an adult.

FOOD—Larval mosquitos eat microscopic organisms (including algae and protozoans) and dead plant material (detritus). Adult females feed on the blood of birds and mammals. Adult males feed on flower nectar.

WATER—Mosquito larvae can only live in water or very moist ground. Adults get the water they need from their foods and dew.

COVER—Mosquitos need wet ground or ponds to lay their eggs in and for the larvae to develop. Adults and larvae hide from predators (mainly other insects, but also some ducks, phalaropes, and swallows) on the leaves and stems of plants.

SPACE—Mosquitos require only a very small pond of water that does not dry out, but the wind may blow them long distances.

ARRANGEMENT—Larvae need a puddle of water that contains adequate food. Flowers, birds and/or mammals must be nearby in order for the adults to find food when they emerge.

- Mosquitos are important to many other living things. Mosquito larvae are important as food to a variety of animals, and adult male mosquitos play an important role by helping pollinate certain flowers.
- When adult female mosquitos suck blood from an animal, they sometimes take in microscopic organisms that cause animal diseases. The mosquitos may then carry the disease-causing organisms to other animals that they feed on. This is a big help to the disease-causing organism but is harmful to the animals that contract the disease.

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NAPAEA FRITTILLARY BUTTERFLY *Boloria napaea*

Napaea frittillaries are found in tundra areas of western, central, and northern Alaska. As adults, their bodies are about ½ in (1.25 cm) long and their wingspan about 1¼ in (3.0 cm). As caterpillars, they are 1½ in long (3.5 cm).

FOOD—Larvae feed on the leaves of specific alpine plants while the adults feed on nectar from a variety of alpine flowers. The specific plants required by the larvae in Alaska are unknown; blueberry and violets may be important.

WATER—They obtain water from dew and their foods.

COVER—In order to avoid parasites and predators, butterfly larvae need well-camouflaged places amidst foliage to form their chrysalis and pupate. Adults and young need many days of sunshine because they can only be active on warm days.

SPACE—The caterpillars live on a single plant or clump of plants; adult butterflies live in a small area—for example, a single ridgetop or valley.

ARRANGEMENT—As larvae they must be able to get food, water, and cover from a single plant (or clump). The plant(s) must be near a flower meadow so adults will be able to find nectar. Both must be in a sunny location.

- Each female butterfly lays about 500 eggs. Only about 2 survive due to parasitism by certain flies and wasps that lay their eggs on the larval chrysalis. The young that hatch out burrow into the chrysalis to eat the butterfly larvae.
- The life cycle of many butterflies, including this one, is poorly known. It is not known whether 1 or 2 years are required for it to develop from egg to caterpillar to adult.

The flower shown in the photo is alpine arnica, *Arnica alpina*. It grows on well-drained, alpine slopes of western, northern, and central Alaska.

DALL SHEEP *Ovis dalli*

Dall sheep are large, hoofed mammals. Females weigh 105-140 lbs (48-63.6 kg); males weigh 200-250 lbs (90.6-113.3 kg). Dall sheep occur in mountainous alpine tundra throughout Alaska, excepting south coastal areas.

FOOD—Dall sheep eat a wide variety of alpine plants, including flowering plants, sedges, grasses, willows, and mosses.

WATER—Sheep get water from dew, puddles, ponds, and snow.

COVER—Sheep need wind-blown ridges in winter, so they can find food when most areas are covered with snow. Winter weather is the major cause of death. Sheep also need cliffs and talus slopes to escape predators such as wolves, brown bear, and (lambs only) golden eagles.

SPACE—Dall sheep ewes, lambs, and yearlings travel in groups separate from groups of adult rams. Each band uses separate winter and summer ranges and returns to the same ranges every year. Each seasonal range includes about 10 sq mi (25.9 sq km) of alpine tundra; bands also wander over much larger areas en route between these.

ARRANGEMENT—In winter, Dall sheep need snow-free sites with a good supply of plants close to cliffs and talus slopes for escape from predators. Sheep, especially ewes with lambs, also need mineral licks (for calcium and magnesium) located en route between their winter and summer ranges.

- Both male and female Dall sheep have horns that grow throughout their lives. The females' horns curve back slightly, while the males grow large horns that eventually form a curl.
- Dall sheep ewes begin having lambs when 3 years old. They have only 1 lamb per year. Dall sheep may live for 12 years.

Alaska Department of Fish and Game, Nongame Wildlife Program, Game Division and Public Communications Sec

P. Arneson

PINE GROSBEAK *Pinicola enucleator*

Pine grosbeaks are large songbirds that live in coniferous forests (spruce, hemlock, or cedar trees) throughout northern North America. Adult males are rose red, while females are gold. They are 8-10 in (20.3-25.4 cm) long, with a 13¾-15 in (34.9-38.1 cm) wingspan. They weigh about 1¼-1¾ oz (40-50 gm).

FOOD—A vairiety of berries, seeds and insects are their main foods.

WATER—Grosbeaks get their water from dew, rain, snow, and puddles.

COVER—Grosbeaks need dense trees or shrubs for escape cover from avian predators (like merlins, sharp-shinned hawks and goshawks) and to conceal their nests from squirrels, magpies, and other predators.

SPACE—Pine grosbeaks have nesting territories of 7-23 acres (3-9 ha). They flock together during winter and may then travel over several square miles.

ARRANGEMENT—Grosbeaks need to be able to find seeds and berries close to trees or tall shrubs.

- When grosbeaks eat berries, they often only digest the fleshy outer covering. The seed remains intact, so the bird may carry it to a new area.
- Grosbeaks lay 4 eggs in a nest beilt of twigs and lined with grasses. They nest on branches of coniferous trees.

MERLIN *Falco columbarius*

Merlins are small falcons that nest throughout northern North America in forest and muskegs. They are 12 in (30.5 cm) long, with a wingspan of 2 ft (61 cm) and weigh 6-9 oz (170.5-255.4 gm). Merlins migrate south to winter in areas from the southern Lower 48 to northern parts of South America.

FOOD—Merlins prey on a wide variety of small birds, particularly songbirds, such as thrushes, waxwings, swallows, sparrows, woodpeckers, and warblers.

WATER—Merlins obtain water from their foods, puddles, ponds, and snow.

COVER—Merlins nest in spruce trees in old stick nests of magpies, and on the ground amidst birch and willow shrubs in treeless areas.

SPACE—Merlin defend only a small area around their nest, but each pair uses a home range of 3.9-7.7 sq mi (10-20 km).

ARRANGEMENT—Merlins need adequate nest sites with easy access to an area with fairly high populations of songbirds.

- In Alaska, merlins usually lay 5 eggs which are incubated mainly by the female. The male helps by bringing food for the female and later, for the young.
- Merlins can fly 25-45 miles per hour. They usually catch other birds in flight.

Forest

HARBOR SEAL *Phoca vitulina*

These small seals occur in coastal fjords, estuaries, large rivers, along rocky shores, and near glaciers along the coast from California to the Bering Sea. They also occur in the North Atlantic Ocean. Harbor seals are about 5 ft (1.5 m) long and males weigh up to 255 lbs (115 kg). The females are smaller, weighing about 80-150 lbs (36.2-68 kg).

FOOD—Fish and crustaceans are their main foods, including pollock, cod, capelin, eulachon, herring, salmon, sandlance, sculpins, also octopus, squid, shrimp, and other crustaceans.

WATER—Seals obtain water from their foods. They also drink small amounts of seawater. Their kidneys are able to get rid of the excess salt.

COVER—Harbor seals need areas for resting (haul-out) and pupping that are undisturbed by people, and in sheltered waters that provide protection from storms and killer whales. They use reefs, sand and gravel beaches, rock outcrops, and ice.

SPACE—It is not known how widely individual seals travel in search of food.

ARRANGEMENT—Seals need adequate food resources within a few hundred feet of the ocean surface and within access to resting and pupping areas.

- Harbor seals are able to dive 675 ft (206 m) below the ocean surface. They may remain underwater for up to 30 minutes. They reduce the amount of oxygen they need by cutting down blood flow to less essential body parts, and by reducing their heart rate from 55-120 beats/min to 15 beats/min.
- Female harbor seals give birth to one pup each year.

KILLER WHALE *Orcinus orca*

Killer whales, or orca, are toothed whales that are in the same family as dolphins and porpoises. They occur in all the oceans of the world. Males may reach 30 ft (9.2 m) in length, while females rarely exceed 23 ft (7 m). Large males have dorsal fins that are up to 6 ft (1.8 m) tall. Adults may weigh up to 16,000 lbs (7,273 kg).

FOOD—Fish (particularly herring and salmon) and octopus are probably their main foods, but they also eat seals, sea lions, seabirds, and other whales.

WATER—Whales have very efficient kidneys that allow them to drink saltwater.

COVER—Killer whales have no predators other than man.

SPACE—Killer whales travel widely in search of food—sometimes, hundreds of miles.

ARRANGEMENT—Killer whales likely need access to large expanses of coastal seas in order to find adequate food.

- Killer whales travel in pods of a few up to 70 or more animals. The pods include males, females, and young.
- Female killer whales give birth to a single young, but biologists do not know how often. Some research indicates that a female may only give birth once every 4-10 years.

Ocean

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RED-NECKED PHALAROPE *Phalaropus lobatus*

These small shorebirds used to be called northern phalaropes. They are 6½-8 in (16.5-20.3 cm) long with a wingspan of 13½-14½ in (34.3-36.8 cm). They weigh 1-1¾ oz (28.4-49.7 gm). They nest in wetlands in northern areas around the world, then migrate south to spend the winter at sea off the coasts of South America and Africa.

FOOD—Phalaropes sit on the surface of lakes, ponds, and the sea and pick up food with their long thin bill. They eat small invertebrates, including insects (mosquito, midge, blackfly, and cranefly larvae), mollusks, and crustaceans (amphipods and fairy shrimp).

WATER—They obtain water from lakes, ponds, and they are able to drink seawater.

COVER—Phalaropes nest amidst sedges and grasses where their 4 brown, splotched eggs are camouflaged from predators like foxes, jaegers, gulls, and weasels. They also use sedges, grasses, and floating materials to hide from predators, like jaegers and falcons.

SPACE—They may use several small ponds for feeding during the nesting season, but they defend only a small area around their nest. In other seasons, phalaropes flock together.

ARRANGEMENT—During nesting, phalaropes need wetlands with abundant invertebrates and dense mats of grasses and sedges for cover. Phalaropes also need areas with abundant food where they are undisturbed before their spring and fall migrations, so that they can put on extra body fat as fuel for their long migration to other feeding areas.

• Male phalaropes are less brightly colored than females, because they need to be camouflaged for their nesting duties. After laying the eggs, the female leaves the nesting area, leaving the male to incubate the eggs and care for the young.

PARASITIC JAEGER *Stercorarius parasiticus*

Three species of jaegers (pronounced ya-gur) occur in Alaska. Parasitic jaegers weigh about 1½ lbs (0.68 kg) and have wingspan of 3 ft (90 cm). Parasitic jaegers occur around the world in the northern hemisphere. They nest on the arctic tundra, then migrate south to winter at sea off the coasts of South America.

FOOD—Small birds (longspurs, redpolls, sandpipers) are their main food during summer. They also take small mammals and the eggs and chicks of gulls, terns, and eiders. In winter, jaegers steal fish from other birds by harassing them until they drop their food; they may also kill small birds.

WATER—Jaegers obtain water from their foods, tundra ponds, and the sea. They have a salt gland that enables them to drink saltwater.

COVER—Jaegers nest in small depressions on the tundra. Their olive to brown, splotched eggs are camouflaged amidst the tundra sedges and lichens. Camouflage is important to protect their eggs from foxes and gulls.

SPACE—Nesting territories of parasitic jaegers have been found to vary from 2 to 14 sq mi (5.2-36.3 sq km) of tundra, probably in relation to the density of prey species.

ARRANGEMENT—Large areas of tundra with small bird and mammal populations are required for nesting. In winter, they must find ocean areas with adequate densities of fish and fish-eating birds from which to steal food.

• Parasitic jaegers do not begin nesting until 3-5 years old. They lay 2 eggs per year and are thought to mate for life. They may live 20-30 years.

• "Parasitic" describes this jaeger's way of life during winter. They parasitize gulls, terns, shearwaters, and other seabirds by stealing food from them.

SINGING VOLE *Microtus miurus*

Singing voles, formerly called Alaska voles, occur on high, well drained slopes of mountain tundra throughout Alaska, except in the southwestern and southeastern regions. These voles are 3½-5 in (9-12.7 cm) long including their short [1-1 5/8 in (2.5-3.6 cm)] tail. They weigh 1-2 oz (28-57 gm).

FOOD—Singing voles eat a wide variety of alpine tundra plants, including flowering plants, grasses, sedges, berries, and lichens.

WATER—They get water from dew, their foods, rain, and snow.

COVER—Singing voles need dry, sandy or organic soil in order to dig their underground burrows. These provide them safety from avian predators.

SPACE—Singing voles live in colonies. Individual voles probably use less than an acre (0.4 ha) during their lifetime.

ARRANGEMENT—Singing voles can only live in areas where there are a wide variety of plants to eat and adequate dry soil for digging burrows.

• Singing voles got their name from the many clicks, chips, and chirps that they make around their colonies. They have 4-12 young per litter.

• In fall, singing voles harvest a wide variety of plants and store them in big piles for their winter food supply. Some piles may contain 8 gal (30 l) of plant material. By excavating the ground and carrying seeds, voles may help a variety of plants survive and spread to new areas.

ERMINE *Mustela erminea*

Ermine, a species of weasel, occur in northern areas around the world. They are found in all parts of Alaska in tundra, wetlands, and muskegs. Females are 5-7½ in (13-19 cm) long, and weigh 1-3 oz (28-85 gm). The larger males are 6-9 in (15-23 cm) long and weigh 2½-6 oz (71-170 gm).

FOOD—Small mammals are their main foods, including voles, lemmings, young ground squirrels and hares, jumping mice, and shrews. Birds, bird eggs, and large insects are sometimes eaten, also.

WATER—Weasels get water from dew, rain, and snow. They drink frequently.

COVER—Weasels raise their young in dens located in rock crevices or underground burrows. Rather than digging their own, they rely on naturally formed crevices or use the burrows of ground squirrels. Weasels need thick shrubbery or rocky areas to hide from their predators—eagles, hawks, and owls.

SPACE—Female weasels use 5-25 acres (2-10 ha), while male weasels may have a home range of 10-37.5 acres (4-15 ha) or more.

ARRANGEMENT—Weasels need small mammal populations for prey within easy access of shrubbery or rock crevices.

• Female weasels give birth to 6-9 young per year; they care for the young by themselves. The males live alone. Weasels are most active at night, but they also hunt during the day.

• Weasels often kill more prey than they can eat at once. They store their leftovers in a cache—then use the stored food when they are unable to find other food.

Reference List

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